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3.1.1 Physical Setting

Site Location

The Coeur d'Alene Basin is located in the Panhandle region of northern Idaho and lies within Kootenai and Shoshone Counties. The Basin is part of the Bitterroot Mountain Range and the Coeur d'Alene Mountains. Much of the area is rural and contains a wide variety of landscape types rich in natural resources including floodplain, steep mountain canyons, and river valley.

Topography and landscape vary in the Basin from relatively open, flat, floodplain areas of the Coeur d'Alene River in the western portion of the Basin to steep, narrow canyons in the eastern portion of the Basin. The floor of the valley near the boundary between Kootenai and Shoshone Counties is roughly 1 mile wide and narrows significantly eastward toward Shoshone County. Valley areas near Wallace are only 0.25 mile wide.

The Purcell Trench, which includes the Rathdrum Prairie, forms the western side of the Basin from Coeur d'Alene Lake to Athol. With the exception of the Rathdrum Prairie, stream channels in the Basin store more unconsolidated, alluvial soil and rock material in the stream bottoms and along the toe slopes than most other areas in the Idaho Panhandle region. These materials are very susceptible to movement (IPNF 1998). The upper North Fork has shallower and weakly weathered, rocky soils. Soils in the lower Coeur d'Alene River area tend to be more highly weathered and contain less rock fragments in the soil profile, making them susceptible to subsoil and substratum erosion (IPNF 1998).

In the mountainous terrain of the eastern portion of the Coeur d'Alene Basin, soils are typically poorly developed, apparently due to the steady erosion of the soil cover on the steep slopes of the canyons. Many areas lack vegetation and consist of loose rock fragments.

Climate

The climate in northern Idaho is influenced primarily by prevailing westerly winds that carry maritime air masses from the North Pacific across the northern Rockies during the winter and spring. This weather pattern persists from the Selkirk Mountains in British Columbia south to the Clearwater National Forest and is characterized by precipitation occurring as long gentle rains, deep snow accumulations at higher elevations, cloudiness, and high humidity. Changes in the position of the jet stream can push inland maritime airflow north causing significant drought in northern Idaho.

Elevation is also a major influence on local climate. The lowest elevations (approximately 2,000 feet), which lie in the western portion of the Basin, are generally the warmest and driest. Areas with higher elevation (approximately 5,500 feet) in the eastern portion of the Basin generally are cooler and have greater annual precipitation.

Summers in the area are generally hot and dry with only about 12 percent of the annual precipitation occurring between July and September. Approximately 50 percent of the annual precipitation occurs between November and February. Winter temperatures are 15 to 25 degrees higher than those in continental locations of similar latitude. These weather patterns make the Basin one of the highest precipitation areas of the upper Columbia River Basin and result in the potential for frequent high water events. The remaining precipitation takes place in the spring.

Local Communities and Area Use

Much of the Basin is rural, undeveloped land. Approximately 32 percent of Kootenai County and 75 percent of Shoshone County consist of federally managed lands, primarily National Forest Lands (IPNF 1998). These areas are rich in natural resources including forests, wildlife, and a number of tributaries and streams that support a variety of aquatic organisms. However, many of these areas are inaccessible due to the lack of roads and the difficult terrain, or the lack of services to support a local economy. Interstate 90 (I-90) has provided limited access to the otherwise rural area.

Tourism related to the use of these natural resource areas for recreational purposes has increased significantly over the last two decades and is one of the fastest growing contributors to the local economy. Recreational use of the area's abundant natural resource areas include riding off-road vehicles, snowmobiling, berry picking, fishing and floating the Coeur d'Alene River, and cross-country and downhill skiing.

Despite the recent economic growth, the lack of development in the Basin has resulted in many small rural communities, primarily along the Coeur d'Alene River and its tributaries. The majority of the population of the Basin live in the cities of Coeur d'Alene and Post Falls, which have populations exceeding 10,000 people. All the other communities in the Basin have populations below 6,500, and in both Kootenai and Shoshone Counties, more than 38 percent of the total population live in rural areas outside of major cities (IPNF 1998).

Communities along the upper Coeur d'Alene River and its tributaries were established and supported in the past by the mining and timber industries, agriculture, and related activities. Mining activities have occurred in the area for more than 100 years and between 1880 and 1965, over 400 sawmills opened and closed in the Basin (IPNF 1998).

The CSM units and stream segment subdivisions described in Section 2.1 were originally established for the ecological risk assessment. Consequently, these divisions generally do not reflect human exposure patterns in the Basin. Geographic subareas defined for human health risk assessment are discussed in Section 3.1.3.

3.1.2 Coeur d'Alene Basin Demographics

Introduction

The purpose of this section is to describe the population and regional characteristics of the Coeur d'Alene Basin HHRA study area. Emphasis is placed on data specific to children, the primary population of concern for lead exposure, and risk co-factors, such as parental income, education, and socioeconomic status, considered to influence the risk of lead poisoning. In general, demographic data are presented according to geographic divisions and data sources. Geographic divisions include HHRA geographic subareas as well as counties, cities, and school districts within the Basin.

The primary source for Basin area demographics is 1990 census data. A discussion of the applicability of 1990 data to current conditions and boundary conflicts between Basin study areas and census tracts is included in following section *Geographic Areas, Data Sources, and Assumptions*. The 1990 census data was used because the census geographic divisions of blocks and block groups could be more appropriately applied to HHRA geographic study areas than county and city boundaries. More current data is presented at a county level, primarily for Shoshone County that is assumed to be representative of the Basin area. Most of the data presented for Shoshone County is referenced from Idaho Department of Commerce (IDOC) reports and documents. Additional data specific to children in Shoshone County and the State of Idaho is referenced from "Idaho Kids Count: Profiles of Well-Being" annual reports. School district annual enrollment data, is the final source of demographic information described in this report. School district data is considered the best and most recent data available for determining the actual numbers of children currently living in the Basin area. Data for most geographic divisions and sources is presented in a comparison format so that Basin area/county/school district demographics can be viewed in relation to the State of Idaho.

Geographic Areas, Data Sources, and Assumptions

Geographic Areas. Demographic data is presented according to the following geographic areas: the Basin, Shoshone County, the cities of Mullan, Osburn, and Wallace, and School Districts #391, 392, and 393 (Table 3-1a). The Basin Area consists of the eight subareas defined for the Coeur d'Alene Basin Study listed in Table 3-1b and shown in Figure 3-1a. All references to the Basin in this report include summary information for the population living within the outer boundaries formed by the eight study areas.

Small portions of both Benewah and Kootenai Counties, as well as a large part of Shoshone County are included in the Basin Area. However, data at a county level is only presented for Shoshone County. Shoshone County was selected as being representative because 73% of the Basin Area population and 51% of the land mass is in Shoshone County. Additionally, the demographic characterization of Shoshone County is considered more typical of the Basin Area than either Kootenai or Benewah Counties. Kootenai County encompasses the city of Coeur d'Alene, that is not inside of the Basin Study Area boundaries and is more urban in character. Kootenai County summary demographics would strongly reflect the influence of the relatively large population and strong economy found in Coeur d'Alene. Benewah County is more rural in character than Kootenai County, however, only a small percentage of the land in Benewah County is included within the Basin Area (3%). In addition, while most of the economies of the communities in the Basin Area are traditionally based in mining, production of forest and wood products has traditionally served as the foundation for the local economy in Benewah County.

Only a small portion of the demographic data presented in this report is for cities within the Basin Area. There are no major cities (i.e., population greater than 20,000) within the Study Area boundaries and the amount of data available for the smaller communities is limited. Data is presented for three cities within Shoshone county (Mullan, Osburn, and Wallace) because all three are defined as study areas in the Basin and are incorporated. No data specific to Silverton were available, although it is also a defined study area within the Basin.

Three school districts are included in the Basin Study Area. These are the Kellogg School District (#391), the Mullan School District (#392), and the Osburn-Wallace School District (#393). A significant portion of the Kellogg School District (#391) includes students residing within the Bunker Hill Superfund Site (BHSS). Data from previous studies done on the BHSS were used to determine the approximate percentage of students within the BHSS boundaries and these students were then excluded from counts of the Basin Area student population.

Data Sources. The primary data sources for Basin demographics are listed below.

1. 1990 Census (CensusCD +Maps V.2.0)

2. Idaho Department of Commerce (IDOC) reports, documents, and Internet accessible data including,
    - Idaho Facts: Information and Statistics About Idaho's People and Economy
    - Profile of Rural Idaho, A look at economic and social trends affecting rural Idaho
    - County Profiles of Idaho
    - Idaho Community Profiles (www.idoc.state.id.us)

3. "Idaho Kids Count: Profiles of Well-Being" annual reports, 1996-2000.

4. School District Data as provided by School Districts 391, 392, and 393.

Data from the 1990 census was the primary source for Basin Area demographics. Census data was used because data was available for small geographic units, referred to as blocks and block groups, that could be overlaid on Basin Area maps to develop demographic information specific to defined study areas. Two areas of concern regarding the use of 1990 census data include the changes that may have occurred in the last ten years and the potential for census geographic grouping boundaries to be different than Basin Study Area boundaries. The applicability of 1990 census data to current conditions is considered throughout the report when corresponding data is available from both the 1990 census and more recent years.

Several factors that have changed over time, as presented in "County Profiles" (IDOC) for Shoshone County, are described in Table 3-2. Some census data is also included. As indicated in Table 3-2, the population of Shoshone County and the cities within the County have shown a significant decrease in population since the 1970s and 1980s. Shoshone County had a population of 19,718 in 1970 and by 1990, that number had decreased by almost 30% to 13,931. However, since 1990, the population has shown comparatively little change with a minor (0.4%) decrease from 1990 to 1998. The cities within the County show similar trends. Between 1990 and 1996, the populations in Mullan and Wallace decreased by 3.2% and 5.5%, respectively. The population of Osburn showed a slight increase of 0.9% for the same time period. By comparison, the State of Idaho showed a 20% increase in population since between 1990 and 1998.

Also shown in Table 3-2 are the changes in economic indicators for Shoshone County such as total employment, mining employment, and unemployment. Data from 1990 is presented from two sources for these factors because census employment data did not match data presented in IDOC reports. This may be due to the time of year the data was reported. IDOC data, rather than census data, is used in the following comparisons because the 1970 and 1980 data are referenced from the "County Profiles" report. Similar to population changes, all three factors showed a significant change from 1980 to 1990. Total employment decreased by 30% and mining employment decreased by 37%. Correspondingly, the unemployment rate increased from 6.7% to 9.9%. Between 1990 and 1996, total employment increased slightly (4%), while mining employment continued to decrease significantly (58%). Tourism and recreation appear to be growth sectors, replacing some of the mining jobs. Unemployment showed a slight increase (0.3%) from 1990 to 1998.

In general, the greatest changes in the Basin Area demographics occurred between 1970 and 1990. Since 1990, changes in population and economic indicators, with the exception of mining jobs, have remained fairly constant indicating relatively little growth or decline. In summary, while 1990 census data is not completely accurate in describing the current population in the Basin Area, it does reflect the current economic and demographic status of the Basin Area.

Geographic boundaries formed by the census groupings, and a potential for a mis-match with Basin Area boundaries, was the second concern in using census data. Census data is available in units referred to as census blocks and census block groups. Census blocks are defined as small areas bounded on all sides by visible features such as streets, roads, streams, and railroad tracks, and by institutional boundaries such as city, town, township, and county limits, property lines, and short, imaginary extensions of streets and roads. Census blocks are the smallest geographic units for which basic demographics are available. Census block groups are made up of census blocks and are the smallest geographic units for which detailed demographics are available. Because of the greater amount of data available for census block groups, these were the preferred regional divisions to use for Basin Area data and are the primary source for demographic summaries presented in this report.

Census block group boundaries were overlaid onto the Basin Study area map on GIS. Block groups falling within Basin Areas were then related to the appropriate study area. Corresponding block group data was then linked to the individual study areas. Figure 3-1b shows the census block groups overlaying Basin study area boundaries. Block group boundaries were similar along the southern edge of the study area, but differed in the northern section. Three block groups fell only partially within the study boundaries. The population and area of block groups with boundaries outside of the study area are listed in Table 3-3.

The block groups that have only a small portion of their entire area within the Basin Areas boundaries make up 30% of the total Basin Area. However, they account for only 11% of the total population. In addition, the land portions of these groups outside of the study area boundaries are in highly forested and mountainous areas likely to have small populations. It is assumed that most of the people living in these block groups are located within or close to the study area boundaries which are relatively proximal to population centers. Based on this assumption, it was determined appropriate to include these groups in the summary demographics.

Sources other than the 1990 census are presented at State, county, city, and school district levels. The primary assumption in using this data is that the information presented for Shoshone County, Mullan, Osburn, Wallace, and the school districts can be considered representative of the Basin as a whole.

General Basin Demographics

The Coeur d'Alene Basin Study Area encompasses approximately 880 square miles of the northern Panhandle region of the State of Idaho, or 1.1% of the total area of Idaho. The study area includes small portions of both Benewah and Kootenai Counties, as well as a large portion of Shoshone County, excluding Lake Coeur d'Alene and the Spokane River. Benewah County and Kootenai County make up 3% and 46% of the Basin Area, respectively. Shoshone County accounts for the remaining 51%.

The Basin Area is considered rural without major cities (i.e., population of 20,000 or more), and higher education facilities or regional medical centers. Approximately 10,500 people, or 1% of the total population of Idaho reside within the study area. Typical of most rural areas in Idaho, the population density is relatively low, with 5.3 persons per square mile living in Shoshone County. Comparatively, the State of Idaho averages 14.8 persons per square mile, while rural areas in Idaho average 6.1 persons per square mile (Profile of Rural Idaho, IDOC). The low population density in Shoshone County is attributable to the fact that approximately 96.2% of the land is forested and is primarily owned by the federal government. Most of the federal land is either national forest or held by the Bureau of Land Management (BLM).

The economy of the region, traditionally based in mining, has declined over the last 10 to 20 years due to mine closures and layoffs and a lack of other industry to replace them. Table 3-2 shows the total mining employment in 1980, 1990, and 1996. Between 1980 and 1996, total mining employment decreased by 74%. As a result, the total population has also showed a declining trend as people move outside of the area seeking jobs. The population of Shoshone County decreased by 29% between 1970 and 1990. Between 1990 and 1998, the population has remained relatively unchanged, with only a slight decreasing trend (0.4%). From 1997 to 1998, Shoshone County is noted as one of only fifteen counties in Idaho to lose population. The population loss in all fifteen counties was attributed to downturns in agriculture, timber, and mining (Profile of Rural Idaho, IDOC).

As the younger generation is forced to move outside of the area to find employment, the population of the Shoshone County is also becoming older as indicated in Table 3-2. The median age of residents in Shoshone County in 1970 was 27.3 years. Since then, the median age has been increasing and in 1998 the median age of residents was estimated at 39.6. Comparatively, the median age of residents statewide in 1998 was 33.5. In 1997, only nine counties in Idaho, including Shoshone, had greater than 15% of their population aged 65 and over. The percent of the population aged 65 and over in Shoshone County in 1997 was 15.7%. In 1970, the percent was less than half that at 7.1%.

The following sections provide additional and more detailed demographic data of the Basin Area according to 1990 census data, as well as a comparison of Shoshone County demographics with other rural counties and statewide data for Idaho. Information specific to the child population as presented in "Idaho Kids Count: Profiles of Well-Being" annual reports and as determined by school district data are also summarized. Finally, the total number of children currently living within the Basin Area (excluding the BHSS) and the number of housing units within the Basin Area were estimated based on the available data.

Basin Area Demographics based on 1990 Census Data

Summary population characteristics for the Basin Area are presented in Table 3-4. The Basin Area makes up approximately 1.0% of the total population of Idaho. The breakdown of the percentage of males, females, and minorities in the Basin Area is similar to statewide data with a 51/49 ratio of male to female and the majority of persons being white (98%). However, there is a higher population of Hispanic persons statewide (5.1%) compared to the Basin Areas (2.1%). The Basin Area population is relatively older with a higher percentage of persons over age 35 (55%) when compared with the overall state of Idaho percent (44%) and correspondingly, a smaller percentage of persons under age 35, at 45% for the Basin Area and 56% statewide. The relatively older population of Shoshone County is attributed to the decline in mining jobs, and the subsequent migration of workers and their families outside of the area in search of employment.

Household characteristics of the Basin population and the State of Idaho are presented in Table 3-5. The total number of households in the Basin Area is 4215 or 1.2% of the total number of households in Idaho. The breakdown of family type is similar for both the Basin Areas and the State of Idaho, with the majority of the families being made up of married couples either with or without children. The percentage of single parent families for both Idaho and the Basin Areas is similar at 7% and 6%, respectively.

Table 3-6 summarizes the housing characteristics of the Basin Area and the State of Idaho. The total number of housing units in the Basin Area is 5651 or 1.4% of the total number of housing units in Idaho. The percentage of occupied housing units in the Basin Area (74%) is lower than the statewide percentage (87%). This may be due to a high number of seasonal units in some of the Basin Area census groups. Both the Lower Basin study area and the Kingston Area contain census block groups with a high percentage of seasonal units, up to 61% of total housing units in a Lower Basin block group near Lake Coeur d'Alene. Block groups in the Kingston Area (Shoshone County) with a high percentage of seasonal units are located near the North Fork of the Coeur d'Alene River. The percentage of renter occupied units is lower in the Basin Area than statewide at 23% and 30%, respectively. The statewide average is likely influenced by a higher number of renters in urban areas.

The breakdown of the number of units in housing for both the Basin Area and the State are similar, with the majority, 73% and 71% respectively, being single unit dwellings. The percentage of 2-9 unit dwellings (duplexes to small apartment complexes) and 10+ unit dwellings (large apartment complexes) is smaller in the Basin Area (7%) than statewide (14%), while the percentage of mobile/trailer homes in the Basin is slightly higher (19%) than statewide (14%). Studies performed in the BHSS indicated that apartment complexes were likely to have a relatively low lead loading when compared to single unit dwellings (TerraGraphics 2000a). This could be attributed to a greater distance (i.e., apartment entries and hallways) between lead sources (tracked soil and dust) and the actual living area in apartment complexes. The total number of 2+ unit dwellings in the Basin Area as estimated from the 1990 census is 376. Mobile/trailer homes are often reflective of socio-econmic status and are unlikely to be a source of lead-based paint. The total number of mobile/trailer homes in the Basin Area as estimated from the 1990 census is 1053 units.

Housing units in the Basin Area are typically older than that reported statewide. Housing age was found to a significant factors influencing lead loadings in a study done on housing units in North Idaho (Spalinger et al. 2000), with older houses (built before 1960) showing a higher loading than newer housing units (built after 1960). This was attributed to two factors, lead paint and a longer exposure period to lead in dust and soils. The use of lead paint in residential homes declined in the 1960s and was banned by 1978. Forty-eight percent of the housing units in the Basin Area were built before 1960, and over half (60%) of those were built before 1940. Statewide, only 37% were built before 1960 and less than half of those (44%) were built before 1940.

Since 1980, the percentage of houses built in the Basin Area is also lower than statewide, at 12% and 18%, respectively. Current data show a similar lag in housing growth for Shoshone County. From 1990 to 1997 housing growth in Shoshone County was 5.6% which fell well behind statewide growth of 21.6% (Profile of Rural Idaho, IDOC).

In addition to being older homes, residents of the Basin Area have also lived in their houses for longer periods of time, as seen in Table 3-6. Almost half (45%) of the housing units at the time of the 1990 census were occupied by persons living in them for a minimum of ten years (i.e., moved in before 1980). Statewide, a higher percentage (65%) moved in to housing units after 1980 and only 34% moved in before 1980. Studies done on the BHSS found that housing units where residents had lived in the unit for 5 years or more showed a lower lead loading rate than units with shorter term residents. Specifically, rentals with a highly mobile population showed higher lead loadings (TerraGraphics 2000a). Of the 4205 occupied housing units in the Basin Area, 954 (23%) were renter occupied.

Median values for housing characteristics for individual block groups within the Basin Areas are listed in Table 3-7. State of Idaho median values for housing characteristics are also included in Table 3-7. The three Basin Areas defined as cities, Wallace, Osburn, and Silverton, do not have census block groups associated with them because none of the block groups are completely or mostly contained within the city Basin Areas (Figure 3-1b). The demographic data for block groups that are partially within City Study Areas are included in the Side Gulches Study Area. Where available, City information is also included in the tables but not in the summary descriptions. As indicated in Table 3-7, the median year built for housing in Idaho is 1970. Basin Area housing is typically older than the overall State housing with twelve of the eighteen block groups in the Basin Area (67%) having a median year built prior to 1970. The median year built for housing in all of the block groups located within the Lower Basin Area (3) was greater than 1970. All three are in Kootenai County. The other three block groups with a median year built after 1970 were in Shoshone County in the Kingston Study Area (2) and the Side Gulches Study Area (1). Housing in the Mullan Basin Area and the City of Wallace are the oldest with a median year built of 1939.

The median value of housing units in 1990 in the State of Idaho as presented in Table 3-7 was $58,000. Basin Area housing values were typically lower than the State median with fourteen of the eighteen block groups included in the Basin Area (78%) having median housing values less than the statewide median. The four block groups with median values greater than $58,000 are located within the Kingston (2) and Lower Basin Study Areas (2). The majority of median rent values in the Basin Areas are also lower than the State median rent value of $330. Of the eighteen block groups in the Basin Area, only one (located in the Kingston Study Area) has a higher median rent value.

Student population and educational attainment data for the Basin Areas and the State of Idaho are presented in Table 3-8. Of the entire student population in Idaho, including preprimary, elementary, high school, and college students, 2416 or 0.8% of the student population live within the Basin Area. The percentage of the population over age 25 without high school diplomas is greater in the Basin Areas (27%) than in the State (20%). Correspondingly, the percentage of the population over age 25 with high school diplomas (73%) is less than the State percentage of 80%. The percentage of the population that attended college is also slightly lower for the Basin Areas at 19%, than the statewide percentage of 24%. The percentage of college graduates and the percentage of the population obtaining a Masters Degree or higher is lower for the Basin Areas than for the State, with combined percentages of 19% and 30%, respectively.

Household income for the Basin Areas and the State area presented in Table 3-9. A slightly higher percentage of the Basin Area population (54%) had incomes in the lower bracket (less than $25,000) than the statewide percentage (49%) and correspondingly, a slightly lower percentage (11%) than the statewide percentage (16%) had incomes greater than $50,000. The median household income from 1990 is presented in Table 3-9 for block groups located within the Basin Areas and the State of Idaho. The three Basin Areas defined for cities, Wallace, Osburn, and Silverton, do not have census block groups associated with them because none of the block groups are completely or mostly contained within the city Basin Areas (Figure 3-1b). The demographic data for block groups that are partially within City Study Areas are included in the Side Gulches Study Area. Where available, City information is also included in the tables but not in the summary descriptions. The median household income for the State of Idaho in 1990 was $25,257. Thirteen of the eighteen block groups within the Basin Area (72%) had lower median household incomes that the state median value. Block groups with median incomes exceeding the statewide median were located in the Kingston Study Area, the Lower Basin Study Area, and the Side Gulches Study Area.

Shoshone County Profile -- Current Data

Table 3-10 summarizes data as presented in “Profile of Rural Idaho,” (Idaho Department of Commerce). The table presents a comparison of data from Shoshone County, the State of Idaho, and urban and rural areas in Idaho. In general, Shoshone County falls behind the state, and both urban and rural Idaho for all economic indicators and income and poverty levels. The unemployment rate is significantly higher in Shoshone County than state, rural, and urban levels at almost twice the percentage of the other areas (12.8%) in 1997. Business growth from 1990 to 1996 fell well behind even statewide rural levels for both total and retail growth, and housing growth from 1990-1997 was significantly behind Idaho's statewide, urban, and rural areas at 5.6% compared to 21.6%, 27.1%, and 13.6%, respectively.

Per capita personal income in 1996 is the only category in which Shoshone County is higher than rural Idaho, and that is only slightly at $16,938 compared to $16,513 for rural Idaho. The statewide and urban values were $19,865 and $21,773, respectively. The median household income for Shoshone County in 1995 was $6,000 to $10,000 lower than Idaho statewide, urban, and rural values. The percent of persons in poverty in Shoshone county in 1995 was significantly higher than all other Idaho areas, with a high percentage (31.2%) of children living in poverty. This data is similar to the data presented from the Kids Count reports in Table 3-11 for 1990, 1994, and 1996, with the percentage of children in poverty increasing for each of the years. Welfare payments per capita were also significantly higher in Shoshone County in 1998 at $771 compared to $378, $452, and $248 statewide, in urban, and in rural Idaho, respectively.

The percentage of housing units built before 1939 and after 1970 are also presented in Table 3-10. Interestingly, almost the same percentage of housing units in Shoshone County were built before 1939 (34.4%) as were built after 1970 (32.5%). In contrast, the statewide, urban, and rural percentages all indicate a significantly higher percentage of housing units built after 1970. Basin-wide, the percentage of housing units built before 1940, as reported in the 1990 census (Table 3-6) was similar to Shoshone County at 29%. Older housing units are likely to have a higher lead loading rate when compared with newer housing units due to the presence of lead paint and a longer exposure period to lead soils and dusts.

Kids Count Data

Data as presented in "Idaho Kids Count: Profiles of Well-Being" annual reports from 1996 to 1999-2000 are summarized in Table 3-11. Kids Count reports are published annually and are intended to provide reliable data to inform citizens and policy makers about the status of Idaho's children and to improve their well-being. Data in Table 3-11 are presented according to Report Years. Annual reports contain a compilation of data from several different years. The actual years that presented data are referenced from are footnoted below the table. For example, population data in the 1996 annual report are based on 1994 estimates. The four annual reports summarized here present a range of data from 1990 to 1998.

Data from Shoshone County is compared to the State of Idaho for several factors affecting the child population in Table 3-11. Between 1994 and 1998, the child population under 18 in Shoshone County showed a decrease of 6%, while the total population remained fairly constant. Statewide, the child population showed a slight increase (3%) between 1994 and 1998, along with the total population that increased by 8%. The decreasing child population is likely due to families moving outside of the area in search of employment. Data for children living in Shoshone County showed higher than statewide percentages of child poverty, single parent families, infant mortality, low birthweight babies, school dropouts, teen births, and teen violent deaths for all years included. As an example, the percentage of children in poverty in Shoshone County increased from 23.7% to 31.2% from 1990 to 1996, while the percentage of children in poverty statewide remained relatively constant at approximately 16% to 17%. Many of these poor social indicators are often associated with a depressed economy.

Economic well being data from the 1999-2000 Kids Count Annual Report are summarized in Table 3-12. Again, Shoshone County exceeds the statewide percentage for economic factors. The percentage of school children receiving free or reduced price lunch in Shoshone County in the 1997-1998 school year was 50%. The percentage increased to 54% in the 1998 to 1999 school year. Statewide, the percentages were lower at 41% and 42% for the 1997-1998 and 1998-1999 school years, respectively. Data as reported by the Kellogg School District (#391) and the Osburn-Wallace School District (#393) in the current school year (1999-2000) indicated that 44% of all students enrolled in the Kellogg district and 40% of all students enrolled in the Osburn-Wallace District received free or reduced price lunch. The Kids Count data was for elementary students only, and indicate that a higher percentage of elementary students receive free or reduced price lunch than secondary (high school) students.

Births paid for by medicaid showed a decrease in Shoshone County from 1997 to 1998 (55% to 42%), however, the percentage remained higher than statewide numbers of 33% and 28% for 1997 and 1998, respectively.

The socio-economic status of children in Shoshone County seems to have decreased over the last decade as illustrated in Tables 3-11 and 3-12. Table 3-13 summarizes the change in the child population, also a decrease, as presented in the 1999-2000 annual report. From 1990 to 1998, the number of children under the age of 5 in Shoshone County decreased by 12.1%. Statewide, the number of children under age 5 increased by 12.2%. The number of children between the ages of 5 and 17 in Shoshone County also decreased by 7.7% while statewide the number increased by 14%. Overall, the total number of children under 18 in Shoshone County decreased by 8.7% and increased in statewide by 13.5%. While the child population in Shoshone County appears to be decreasing, negative factors affecting children continuing to live in the area seem to increase (Table 3-11). Socioeconomic status of families has been noted to be a significant factor affecting children's blood lead levels and environmental media in numerous studies (Pirkle et al. 1998, Brody et al. 1994, Clark et al. 1985, Bornschein et al. 1985) .

School District Data

Tables 3-14 and 3-15 summarize school district enrollment data for the Kellogg School District (#391), the Mullan School District (#392), and the Osburn-Wallace School District (#393). School district data was obtained with the help of the three districts involved. The Kellogg School District has the highest enrollment numbers over the last decade followed by the Osburn-Wallace District and finally, the Mullan School District. Overall, enrollment in all three districts have shown a consistent decrease in the total number of students since the early 1990s. Total enrollment in the three districts decreased by 13% from 1992 to 2000. Enrollment data is shown graphically in Figure 3-2.

A significant portion of the Kellogg School District (#391) includes students residing within the Bunker Hill Superfund Site (BHSS). However, the BHSS is not included in the current Basin Study Area. In order to exclude the student population residing within the BHSS, the number of students residing in the BHSS was estimated using a study done in 1999 which showed that approximately 68% of the students enrolled in the Kellogg School District lived within the BHSS (TerraGraphics 2000a). Therefore, the total enrollment of students in the Kellogg District living outside of the BHSS was determined by subtracting 68% of the total number of students given for the Kellogg District. The adjusted data are shown in Table 3-14. Table 3-15 shows the breakdown of student enrollment data by grade. The percentage of students in each grade is similar (all between 7-9%).

Estimation of the Child Population

Children eligible for the blood lead sampling program conducted as part of Basin risk assessment studies are defined as children between the ages of 9 months through 9 years. In order to determine the percent of the population sampled in this program, the total number of children in the Basin Area between the ages of 9 months and 9 years was estimated. Three sources were considered in determining this estimate. The first was the 1990 census data. Census estimates are available for both Shoshone County (a major portion (73%) of the total Basin Population) and the Basin Area as a whole. The second source is the school district enrollment data. Not all children living in the Basin attend one of the three districts, for example, some attend private schools or are home schooled. Based on Basin Area census estimates, children attending private school comprise approximately 5% of the entire student population. The third data source is "Kids Count" estimates of the child population in Shoshone County. All three sources and the sample populations based on these sources are summarized in Table 3-16. School District enrollment totals do not include students within the BHSS, but were increased by 5% to account for students enrolled in private schools. Assuming an even distribution of children in each age group (Table 3-15), the sample population estimates were made using the following method.

1. The total number of children from a certain age range as given in a source (e.g., 2484 children in the Basin Area between 0-17 years, as referenced from the 1990 census data) was divided by the total number of years in the age range (18). The result is the number of children in each age group.

2. Children eligible for the sample program span a total of 9 1/3 years. Therefore, the number obtained in step 1 (children in each age group) was then multiplied by 9.33 years (9 years + 3 months) to determine the estimated sample population.

The results from Basin Area 1990 census data as well as the Shoshone County estimates are slightly higher than the school district data. The reason for the discrepancy is likely a small number of children in living outside of the three school districts and portions of Shoshone County not included in the Basin Study Area. The sample population estimates range from 1025 (2000 school district data) to 1288 (1990 Basin Area Census data). Assuming a 13% decrease in enrollment since 1990 yields an estimated 9 month to 9 year old childhood population of approximately 1120 children based on the 1990 census data. The estimated childhood population for the eight geographic subareas of the Basin is then 1025-1120 individuals based on the school district and 1990 census data, respectively.

Estimation of the Total Number of Housing Units and Yards

Basin Area sampling has included soil samples from yards in Basin Area housing units. In order to determine the percentage of yards that have been sampled it is necessary to know the total number of yards in the Basin Area. This was estimated by two methods. The first estimate was based on housing unit data from the 1990 census and the second was based on a combination of the current number of sewer hook-ups in the area and 1990 census data.

Census data were used to estimated the number of housing units by assuming that each housing unit counted in the 1990 census corresponded with one yard. However, housing unit, as defined by the census, is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, intended for occupancy) as separate living quarters. Therefore, there is not necessarily a yard associated with each unit (e.g., an apartment) and the estimate of yards based on census housing units would likely be an overestimate. The percentage of total housing units in the Basin Area with two or more units in the building, however is small (7%), with the majority of all units being either single unit dwellings or mobile/trailer homes. The total number of housing units in the Basin Area based on 1990 census data, with and without the Lower Basin Area included, is 5651 and 3740, respectively (Table 3-17). Both numbers exclude housing units within the BHSS. The number of yards in the Basin Area was then estimated by subtracting 7% of the total number of housing units. The resulting estimate of the total number of yards in the Basin Area based on 1990 census data is 5255. The number of yards in the Basin Area (excluding the BHSS and the Lower Basin Study Area) was estimated the same way at 3728. The Lower Basin Area was excluded in the second estimate for future comparison with sewer district data.

The second method used to estimate the total number of yards was done by combining current information on the number of sewer hookups in the Basin Area (with the exception of the Lower Basin) with 1990 Census data. Data was used from two sewer districts, the South Fork Coeur d'Alene River Sewer District and the Kingston-Cataldo Sewer District. Sewer district data for the Lower Basin Area was not readily available and was not included. It was possible with sewer district data to separate apartment buildings and their individual units so that only one yard was associated with each building, however, some units are not on public sewer (e.g., units using septic tanks) and therefore the housing unit estimate based on sewer data alone would be low. Data on the number of septic tanks in the Basin Area was not available because permitting was not required until the 1970s and septic tanks installed before then would not be counted. In addition, between the 1970 and 1990, many of the permits issued were not available on record.

In order to account for housing units not on public sewer, the percentage of housing units from the 1990 census data not on public sewer was assumed to be similar to current percentages.
Basin Area public water and sewer data are summarized in Table 3-17. Data for the Basin Area excluding the Lower Basin is shown for both the 1990 census and data collected by the sewer districts in the Basin Area in 1999. The 1990 census data indicated that approximately 72%

(2873) of the housing units in the Basin Area w/o the Lower Basin were serviced by public sewer. The number of public sewer hook-ups in the same area in 1999 was estimated by the sewer district at 3065. The total number of housing units in the Basin Area w/o the Lower Basin in 1999 (italicized) was then estimated by assuming that 3065 units make-up 72% of the total number of housing units. The resulting estimate of the total number of housing units in the Basin Area without the Lower Basin is 4257.

After determining the total number of housing units using sewer district data, buildings with multiple housing units but only one yard (apartments and duplexes) were counted as one yard and the remaining number of units was subtracted from the housing unit total to estimate the total number of yards. It was assumed that housing units with septic tanks were not multi-unit dwellings. The estimated number of yards as shown in Table 17 is 3570. This number does not include yards in the Lower Basin. The number of yards as estimated strictly by census data was 3728 excluding the Lower Basin and 5255 including the Lower Basin.

Housing unit estimates and corresponding yard estimates separated according to Basin Study Area are summarized in Table 3-18. The sewer hook-up data shown in Table 3-18 was obtained from 1999 sewer district data. The estimates are based on the percentage of public sewer hook-ups being 72% of the total number of housing units as described above.

3.1.3 Human Health Exposure Areas

It was necessary to establish geographical areas on the basis of potential human exposure. Within the CSM units, nine geographic areas were identified as human health exposure areas according to the route of human exposure evaluated and the public use patterns in each area (Figure 3-1):

- Lower Basin,
- Kingston,
- Side Gulches,
- Osburn,
- Silverton,
- Wallace,
- Nine Mile,
- Mullan, and
- Blackwell Island.

The Lower Basin includes all of the Coeur d'Alene River west of Cataldo, Coeur d'Alene Lake, and the Spokane River (CSM Units 3, 4, and 5, respectively). Human health concerns in Coeur d'Alene Lake (CSM Unit 4) from exposure to metals through surface soil, sediment and surface water were evaluated in the expedited screening level risk assessment for common use areas (Appendix B). In that assessment, all sites except Harrison Beach and a recreational area on Blackwell Island passed the screening process and, therefore, required no further evaluation. Harrison Beach has been evaluated as part of the Lower Basin. The Spokane River (CSM Unit 5) has been evaluated separately.

3.1.4 Characterization of Potentially Exposed Populations

Residents and visitors to the Basin could be exposed to affected media during their normal daily activities including home life, recreation, and work. However, exposure of individuals to affected media will not be the same across the Basin because of differences in the following factors:

- Location of their home,
- Affected media in the areas in which they spend time,
- Frequency of use of the local recreation areas, and
- Availability and use of public services (i.e., drinking water).

For example, concentrations of metals in media within the Basin are not uniform, indicating that some residents will be exposed to lower concentrations in their home than others. Some individuals may have private gardens or collect, grow, and/or eat local vegetables, fruit, livestock, fish, and wildlife, while others may not. Some residences and businesses have private drinking water supplies, while others use a municipal source. Because individuals in the Basin live in different areas, under different conditions, and in different lifestyles, exposures from place to place and person to person can differ significantly.

However, evaluation of exposure for each individual is neither practical nor useful in determining appropriate remedial action. Therefore, individuals have been combined into groups of major receptor types that have similar exposure to affected media in terms of the type and extent of exposure. The following subsection describes the major receptor types, as well as cases in which multiple exposures may occur as a result of participation in multiple activities within the Basin.

Major Exposure Scenarios and Potential Receptors

Residential. Both children and adults who reside in the Basin could be exposed to several of the affected media while living in their homes. Residential exposure scenarios are based on judgements about activities that might be undertaken by Basin residents but may not necessarily result in exposure. Many daily activities that could result in exposure can occur both within and outside the residence. Regular use and maintenance of the home and yard as well as leisure activities create the potential for exposure to affected media. In addition, residents may grow vegetables or eat locally grown produce and thus be subjected to exposures via the food chain.

Neighborhood Recreational. In addition to exposure in their homes and yards, residents might have other opportunities to be exposed to affected media within their local neighborhoods. Residents who live very near affected creeks or rivers and their shores, near local parks or schools with affected media, or near waste piles of rock or tailings might also be exposed to affected media during leisure and recreational activities near their home.

Public Recreational. Recreational exposure in neighborhoods is likely similar to that in public recreational areas. However, individuals from outside the Basin might use public recreational areas while not being exposed to affected media in their homes. Similarly, residents of the Basin might travel to public recreational areas in different locations within the Basin. For example, a resident of a rural upriver community might choose to travel to recreational areas in the Lower Basin, which are unavailable in the steep canyons upriver. Public recreational exposure was quantified separately from residential and neighborhood recreational exposure because of the potential for cross-Basin travel and the possibility that visitors from outside the Basin will use public recreational areas within the Basin.

Occupational. Individuals in the Basin may come in contact with affected media while performing their daily work activities. In general, occupational exposures are less significant than residential and recreational exposures because of limited contact with affected media. However, for some workers, such as individuals who have intensive contact with soil during excavation work, exposure might be relatively high for short periods, depending on the work location. Therefore, intensive occupational exposure to affected surface and subsurface soil was evaluated for a “construction worker.” Other potential on-the-job exposures, such as drinking tap water or coming in contact with surface water or sediment, were not evaluated because no exposure or infrequent, minor exposure is expected to occur or because the type of exposure was already being evaluated for another major receptor type.

Subsistence. Coeur d’Alene Tribal resident activities extended throughout the Basin. Site-specific media contaminant levels are used in the HHRA for available data collected near the mouth of the Coeur d’Alene River and the Chain Lakes area. Traditionally, tribal members occupied many areas of the Basin and utilized the resources that each area had to offer, especially the water bodies and waterways. For the purposes of the HHRA, Coeur d’Alene Tribal authorities have requested that two specific tribal exposure scenarios be investigated, developed, and utilized. Those scenarios are the Traditional Tribal Subsistence Lifestyle and the Current Subsistence Lifestyle. The Traditional Subsistence scenario considers the aboriginal riparian resident lifestyle traditionally practiced by the Tribe. The Current Subsistence scenario considers those tribal members that continue to practice a subsistence lifestyle today.

Traditional Subsistence activities were carried out in numerous locations throughout the Coeur d’Alene Basin and included diverse locations. Current contaminant concentrations vary widely by media and geography throughout this area. The two exposure scenarios utilize the available site-specific sediment, soil, and tissue exposure point concentrations data obtained from the mouth of the Coeur d’Alene River and for the Lower Basin area, including the Chain Lakes. This area corresponds with one of the main Tribal units resident locations in traditional times, and a potential future harvest area for the current subsistence scenario.

Multiple Exposures. Individuals in the Basin might fit into more than one receptor type and therefore be exposed to affected media in more than one way. Some examples include the following:

- Local residents who are also exposed during neighborhood recreation (including exposures via the food chain),

- Local residents who also use recreation areas in the Basin (including exposures via the food chain), and

- Local residents who also work locally as construction workers.

The related increases in incremental risk due to multiple exposures are discussed in Section 5.

Potential Exposed Residents by Area

Potential human receptors who might be located in each of the human health exposure areas are described in the following subsections and are summarized in Table 3-19a.

Lower Basin. The Lower Basin includes the lower Coeur d'Alene River and its associated floodplain. Residential population density is sparse throughout the area in Cataldo, Dudley, Rose Lake, Lane, and Medimont. Both adult and child residents in the Lower Basin could be exposed to affected media. Residents who live near the lower Coeur d'Alene River might also be exposed to affected media in their neighborhood while engaging in recreational activities. Although both adults and children could be exposed, exposure is likely greater and more frequent for children who play for longer periods of time, such as children between 4 and 11 years old. The ample available natural resources and public recreation in the Lower Basin also provide an opportunity for visitors to the area to be exposed to affected media in public recreation areas including the lower Coeur d'Alene River and associated beaches and picnic areas. It is also possible that construction and excavation workers in the Lower Basin might be exposed to affected soil.

Kingston. Within the Kingston area are the confluence of the North Fork and the South Fork (NS confluence), Pine Creek, and their extensive tributaries. The upper portions of Pine Creek were considered relatively uncontaminated and, therefore, were not evaluated in the HHRA. Residences in the Kingston area are sparse throughout the area in the town of Kingston, as well as along Pine Creek, and in Enaville. (The portion of Pine Creek that is within the boundary of the 21-square-mile Bunker Hill Superfund site has been excluded from this evaluation.) Both adult and child residents in the Kingston area could be exposed to affected media. Residents who live near the NS confluence or Pine Creek might also be exposed to affected media in their neighborhood while engaging in recreational activities. Although both adults and children could be exposed, exposure is likely greater for children between 4 and 11 years old. Although less accessible than those in the Lower Basin, the public recreation areas in the Kingston area, specifically the NS confluence, also provide an opportunity for visitors to be exposed to affected media in beach and picnic areas. It is also possible that construction and excavation workers in the Kingston area might be exposed to affected soil.

Side Gulches. The Side Gulches include Moon Creek, Twomile Creek, Terror Gulch, Montgomery Gulch, and Nuckols Gulch, Sunny Slopes, the lower portion of Big Creek, and Elk Creek Pond and its surrounding area. Residences in the Side Gulches area are located primarily along Big Creek with sparse households along the other creeks and gulches. Both adult and child residents in the Side Gulches area near Big Creek could be exposed to affected media. Residents who live near Elk Creek Pond and its surrounding area might also be exposed to affected media in their neighborhood while engaging in recreational activities. Although both adults and children could be exposed, exposure is likely greater for children between 4 and 11 years old.

Osburn. Both child and adult residents of the town of Osburn could be exposed to affected media in their homes and yards. Residents who live near the South Fork could also be exposed to affected media while playing in their neighborhood. It is also possible that construction and excavation workers in the town might be exposed to affected soil.

Silverton. Both child and adult residents of the town of Silverton could be exposed to affected media in their homes and yards. Residents who live near the South Fork could also be exposed to affected media while playing in their neighborhood. Children who play at neighborhood parks and schools with affected media could be exposed. Visitors to public parks and schools in the area might also be exposed to affected media in these areas. (See Section 2.2 for a list of parks and schools.) It is also possible that construction and excavation workers in the town might be exposed to affected soil.

Wallace. Both child and adult residents of the town of Wallace could be exposed to affected media in their homes and yards. Residents who live near the South Fork of the Coeur d'Alene River could also be exposed to affected media while playing in their neighborhood. Children who play at neighborhood parks and schools with affected media could be exposed. (See Section 2.2 for a list of parks and schools.) Visitors to public parks and schools in the area might also be exposed to affected media in these areas. It is also possible that construction and excavation workers in the town might be exposed to affected soil.

Burke/Nine Mile. The Burke/Nine Mile area includes the residents in the communities of Mace, Burke, Gem, Blackcloud, and Woodland Park, which are located along Nine Mile and Canyon Creeks. Both child and adult residents of these small rural communities could be exposed to affected media in their homes and yards. Residents who live near Nine Mile and Canyon Creeks could also be exposed to affected media while playing in their neighborhood. Children who play on waste piles in their neighborhood could be exposed to the highest concentrations of metals (see list of waste piles in Section 2). It is also possible that construction and excavation workers in these communities might be exposed to affected soil.

Mullan. The Mullan area includes the area in and around the town of Mullan and the uppermost portion of the South Fork. Both child and adult residents of this community could be exposed to affected media in their homes and yards. Residents who live near the South Fork, which includes most of the residents in the area, could also be exposed to affected media while playing in their neighborhood. Children who play on waste piles in their neighborhood could be exposed to the highest concentrations of metals. Waste pile exposures are quantified and evaluated for Morning

Mine Dump in the outskirts of Mullan. It is also possible that construction and excavation workers in these communities might be exposed to affected soil.

Blackwell Island. On Blackwell Island, there is a recreation area with beach and picnic areas that can be accessed by the public. Visitors to this area could be exposed to affected media on and around the island.

3.1.5 Populations of Potential Concern

Certain populations in the Basin could be more sensitive to contamination or more likely to be subjected to greater exposure than the average individual in each of the receptor groups. These populations include infants and children and individuals with subsistence lifestyles, including some members of the Coeur d'Alene Tribe. The following subsections briefly describe these populations in terms of the characteristics that either make them more sensitive or more likely to have greater exposure. Section 4 and Appendix H provide greater detail of the effects of each chemical on the populations of concern.

Infants and Children

Because of their physical vulnerability and small body size, infants and children are often assumed to be more susceptible to the potential toxic effects of chemicals in the environment. Studies have shown that susceptibility clearly depends on the chemical and on the exposure situation. Although these differences are chemical-specific, infants and children are a unique population that needs to be considered in risk assessments (Guzelian, Henry, and Olin 1992). Their risks may differ qualitatively and quantitatively from those of adults for a variety of reasons including differences in behavior (i.e., frequent hand-to-mouth behavior), physiology, metabolism, pharmacokinetics, diet, and exposure environment.

Some of the COPCs evaluated in this risk assessment are known developmental toxicants. Because chemicals can cross the transplacental barrier, pregnant women and women of child bearing age are also considered a sensitive population in order to protect the developing fetus. The toxicity profiles in Appendix H contain further chemical specific details regarding the effects of developmental toxicants.

Aspects of physiology that differ between children and adults include differences in intake per unit of body weight of air, food, and water (and associated chemicals). These differences are related to differences in rates of respiration and circulation and cell proliferation rates in many organs, which are often greater in children than in adults.

Similarly, dermal, intestinal, and respiratory absorption may be greater or lesser in children depending on the chemical and the exposure scenario. During times of rapid growth, the amount of food ingested per unit of body weight may be greater for children (Plunkett, Turnbull, and Rodricks 1992).

There are major metabolic differences between children and adults that can significantly affect their ability to respond to chemical exposure. Some metabolic systems are more efficient in childhood than during adulthood (such as cytochrome P-450 activity) while others are less efficient. Chemical-specific metabolic differences between children and adults are also evident (Guzelian, Henry, and Olin 1992).

Pharmacokinetics, including the absorption, distribution, and excretion of various chemicals, differs between children and adults on a chemical-specific basis. These differences are sometimes a result of developmental changes in membrane permeability and in the binding and storage of chemicals (Guzelian, Henry, and Olin 1992; Plunkett, Turnbull, and Rodricks 1992).

The diet of a child is often quite different from that of adults. Dietary differences, such as the amount of vegetables, fruit, fish, or red meat consumed, can have an effect on the amount of chemical ingested in food items. In addition, nutritional status has a profound effect on toxicity response.

One of the most obvious differences between adults and children is the difference in physical environment and living habits. For instance, children are generally closer to the floor, carpet, and ground, and their daily activities, hand-to-mouth behavior, and lack of occupational exposure significantly influence the amount of chemical exposure that occurs.

As a result of these influential differences, infants and children often receive a different effective dose of a chemical than adults, even when chemical concentrations in affected media are the same. Therefore, in this assessment, children were considered a sensitive population for all COPCs and were evaluated appropriately. Specifically, both children (0 to 6 years of age) and adults were evaluated for residential and public recreational exposure types. Neighborhood recreational exposures were evaluated for children between the ages of 4 and 11 because maximum exposure was anticipated in this age group as a result of their play habits and their interaction with the physical environment.

Subsistence Lifestyles

The traditional economy of the Coeur d’Alene Tribe was characterized by a complex and highly structured system of food source production, distribution, and consumption. The Plateau people generally practiced a seasonally based transhumance, an annual cycle of utilization of specific economic sources. This travel involves the return annually to well known camps for root digging, fishing, hunting, and high elevation hunting and berry picking. The basic winter village in the Basin is the center of the cycle and is never fully abandoned by certain individuals of the society, especially the elderly and children too young to travel on their own but too heavy to be carried (Sprague 1999).

The following paragraph from Teit compares the Coeur d'Alene to the rest of the Plateau Culture Area (including the Umatilla Tribe):

> At certain seasons considerable numbers of people congregated at famous camas and other root-digging grounds. They also went to the Spokane for salmon fishing, trading, and sports. These journeys were made on foot, for there were no water routes leading to these places. On the whole the people were fairly sedentary, and

> most of them lived the greater part of the year on their home grounds, although they had no permanent houses or villages, unless the long communal dance houses of the larger villages may be so called. Being a semisedentary people, and living in a country where wood, bark, and vegetal materials of many kinds abounded, the Coeur d'Alene developed the arts of fishing, canoe making, and textile work in weaving of mats, bags, and baskets, probably to a greater degree than any of the neighboring tribes [Teit 1930:151].

There were "three, possibly four, units corresponding to divisions of the tribe." These were (1) Coeur d'Alene Lake and/or Spokane River; (2) Coeur d'Alene River; and (3) St. Joe River (Teit 1930). Because of their proximity to the fishing grounds at Spokane Falls the first group tended to be more permanent. The second group was located around the mouth of the Coeur d'Alene River and upstream near Harrison, Medimont, and between Killarney Lake and Robinson Creek near what is now Lane. The third group resided at the mouth of the St. Joe River and west of Mission Point on Lake Coeur d'Alene; the six villages in this group extended upriver as far as modern St. Maries (Teit 1930:38-39).

The Coeur d'Alene were largely dependent upon Lake Coeur d'Alene and its tributaries; perhaps more than any other Plateau group. Water played a central role in all aspects of life, from birth to death and was included in all major cultural events. Individuals spent a great portion of their time in the water; generally through fishing, hunting, gathering, bathing, recreating, and other various activities. The special emphasis on water and its ritual importance is demonstrated in a statement by Father Point in 1843 that the sign of the cross was made at all important events but especially always before smoking the pipe or drinking water (Point 1967:94).

The Coeur d'Alene were also involved in harvesting, consuming and utilizing primarily riparian resources. Much of the raw material used in the manufacture of various necessary items were obtained primarily from within the riparian environment (Nugent 1997). The areas of manufacturing that the Coeur d'Alene were especially noted were in the use of bark and mats. Mats were made of the cat-tail and tule plants, both of which grow in water. Mats were made by weaving and sewing and were used as lodge covers. The preparation of hides involved soaking in water for long durations to loosen the hair. The finished product was often painted green from an algae collected from stagnant pools. For stone-boiling the Coeur d'Alene used woven baskets like their neighbors but unlike several others, they also used bark containers (Ray 1942:136).

Seasonal round activities were also intimately associated with tribal social, political and religious organization. Many aspects of traditional Coeur d'Alene tribal organization were based upon gender and age, with strong incentives for conformance. Men were mainly involved with hunting and fishing, but also participated in gathering. Women were mainly involved with gathering, fishing, and food processing and preparation. The division of labor was distributed evenly among tribal members. Children also helped with the work, particularly gathering and fishing.

The division of the harvest took place according to a certain political structure. The individuals responsible were given a large portion of the kill, while the particular chief involved with the hunt received a portion for distribution to needy individuals within the tribe (Nugent 1997).

All of these activities are undertaken collectively in family or tribal groups and involve children and women of reproductive age, that are considered the population at greatest risk.
These activities also result in substantially greater potential exposures associated with consumption rates of resident fish and riparian vegetation, and soil and sediment contact rates associated with typical residence and harvest practices for both ingestion and dermal routes. Due to the Tribe's dependence on water from Lake Coeur d'Alene, the surrounding lateral lakes, and the Coeur d'Alene River and close interaction with the natural environment, maximum exposures were assumed.

3.2 IDENTIFICATION OF EXPOSURE PATHWAYS

An exposure pathway represents the course a chemical takes from its source to the exposed individual. An exposure pathway consists of four parts: (1) a source and mechanism of chemical release, (2) a retention or transport medium, (3) a point of potential human contact with the affected medium, and (4) an exposure route at the contact point (USEPA 1989). Without all of these four parts, a potential exposure pathway is not complete and, therefore, not a risk to human health.

Exposure pathways that were considered in this HHRA include standard pathways common to most HHRAs at hazardous waste sites. A few less common pathways relevant to exposure in the Coeur d'Alene River Basin were also considered. The following points of potential human contact and the potential exposure routes for each of the receptor types were considered and are discussed in the subsequent sections:

- Ingestion of and dermal contact with soil and house dust (residential, neighborhood recreational, public recreational, occupational, and subsistence residents),
- Inhalation of dust from soil (residential and subsistence residents),
- Ingestion of and dermal contact with tap water (residential residents),
- Ingestion of and dermal contact with surface water (neighborhood recreational, public recreational, and subsistence residents),
- Ingestion of and dermal contact with sediment (neighborhood recreational, public recreational, and subsistence residents),
- Ingestion of homegrown vegetables (residential residents),
- Ingestion of locally grown beef (residential residents),
- Ingestion of fish (public recreational and subsistence residents),
- Ingestion of wild game (public recreational and subsistence residents), and
- Ingestion of wild plants (residential and subsistence residents).

All the pathways discussed in the following sections apply to both current and future conditions except future use of groundwater (Nine Mile area only) and future tribal use of the floodplain of the lower Coeur d'Alene River (Lower Basin). Section 3.2.1 describes the sources, fate and transport mechanisms, and affected media in the Coeur d'Alene Basin. Section 3.2.2 presents the potentially complete exposure pathways that were not selected for quantification in the HHRA, as well as the rationale for exclusion. Section 3.2.3 presents the potentially complete exposure pathways that were quantified in the HHRA by exposure area. The potential exposure pathways that were considered for the Coeur d'Alene Tribe traditional and current subsistence are described in Section 3.2.4.

3.2.1 Sources, Fate and Transport, and Affected Media

Diagrams of potential sources, fate and transport mechanisms, and affected media are shown in Figures 3-3 through 3-11 for each geographic area. These figures also show the potential receptor types and exposure media that are discussed in Sections 3.2.2 and 3.2.3. A general description of possible sources, transport mechanisms, and media is provided in the following text; however, not all of these sources, mechanisms, and media are present in each area.

As a result of mining activities in the Basin, surface and subsurface soils containing high concentrations of metals have been disturbed and redistributed throughout the Basin to construct roads and railroad beds, to supplement agricultural areas, and to be stored in waste piles. Mining activities have caused releases of concentrate, mill tailings, and waste rock to contaminate surface and subsurface soils with high concentrations of metals. This material has subsequently been eroded and transported along the Coeur d'Alene River. It has also been used as fill in construction of roads, Interstate 90, and the Union Pacific Railroad. When soils with high concentrations of metals are exposed to air, a natural geochemical process can occur in which the sulfide form of the metals is oxidized. These oxidized metals can adsorb to soil particles and be transported from the landscape with the soil via surface runoff and wind and water erosion to nearby creeks and rivers. Many of the metals in the creeks and rivers are adsorbed to transported soil particles as well as cobble, particulate matter suspended in the water column, and sediment. Some metals are released into the water column via dissolution. As a result of the frequent flood events that occur in the Basin and the natural migration of the river channels, this sediment and other organic material have been resuspended, carried, and redeposited in many downstream locations within the floodplain, into Coeur d'Alene Lake and beyond. This redeposited sediment can cover upland areas or remain in downstream channels as bedload sediment.

Metals adsorbed to soil particles can also be released via dissolution and become soluble in rainwater and soil pore water that eventually percolate through the soil layers to groundwater. Likewise, metals adsorbed to soil particles can be transported via wind erosion as fugitive dusts that eventually settle on surrounding areas.

As a result of these processes, high metals concentrations originating in subsurface soil deposits have been transported to and detected in adjacent surface soil, groundwater, surface water, sediment, upland soil, and dust.

3.2.2 Potentially Complete Pathways Excluded From Quantification

Dermal Contact With Tap Water and Surface Water

The uptake of inorganic chemicals through the skin from water is primarily limited to compounds dissolved in water. While water soluble metals are absorbed at higher rates than insoluble ones, the penetration rate of water through the skin is slow (0.001 cm/hour) (USEPA 1992a). Several investigators have also shown that electrolytes in dilute solution penetrate the skin poorly (USEPA 1992a). Absorption rates similar to that of water have been observed for the chloride salts of zinc, cadmium, and mercury, and for sodium chromate and silver nitrate (Wahlberg 1968; Skog and Wahlberg 1964). The recommended dermal permeability factor for metals is quite low at 0.001 cm/hour (USEPA 1998b) and it applies only to the dissolved fraction. Therefore, dermal contact with metals in tap water and surface water, although a complete pathway, was not quantified in the HHRA.

Inhalation of Fugitive Dust

Inhalation of dust has been evaluated in previous risk assessments in the Basin and was determined not to be a primary contributor to exposure and risk (Weston 1989), although inhalation was identified as a risk at the Bunker Hill Superfund Site (USEPA 1990a). Changes that have occurred at the Bunker Hill Superfund Site since the risk assessment have resulted in decreased dust concentrations from metal source areas at the site. The screening process used to select COPCs examined available soil data and screened out all chemicals in this pathway because measured concentrations were less than the SVs. The SVs were estimated using the PEF, as discussed in Section 2.4.1, which relates the chemical concentration in soil with the concentration of dust particles in the air. In addition, the results of ongoing dust monitoring indicate that this exposure pathway is being sufficiently controlled to preclude significant exposures.

Ingestion of Beef Cattle Grazing in Floodplain

Cattle graze in the floodplain meadows along the lower reaches of the Coeur d'Alene River. There are four known ranching operations in the floodplain (USFWS 1999). Because the meadows are periodically inundated with floodwaters, the meadow soils are contaminated with mining-related chemicals. Therefore, grasses in these meadows may take up inorganic chemicals, which may then be eaten by grazing cattle. Furthermore, cattle directly ingest soil on and around the floodplain grasses. Therefore, the consumption of local beef may result in the ingestion of some inorganic chemicals.

Ingestion of metals in beef could occur. However, because of the absence of beef tissue data, this pathway was not quantified in the HHRA. The consequences of excluding this pathway are discussed in Section 7.

Ingestion of Waterfowl and Large Game From Hunting

Waterfowl and large game that feed, live, and/or breed in the area are exposed to inorganic chemicals via the consumption of potentially affected plants and the incidental ingestion of affected soil. Dermal contact with soil and ingestion of and dermal contact with contaminated water are also routes that might affect metal concentrations in waterfowl and large game. Previous investigations have shown that lead and cadmium accumulate in blood and some tissues of small mammals and birds in the Basin (Szumski 1999; Audet et al. 1999). Waterfowl deaths due to acute lead toxicity have been documented (Audet et al. 1999).

Both residents and nonresidents might hunt, capture, and eat waterfowl and large game in the area, thus being exposed indirectly to inorganic chemicals. Although this pathway is complete, it is not expected to result in a significant exposure for the majority of the population, and, therefore, it was not evaluated quantitatively for metals other than lead. Exclusion of this pathway for waterfowl is supported by previous Basin studies that investigated tissue metal concentrations in waterfowl (Weston 1989). Results indicate that although metals tend to accumulate in kidneys of ducks collected within the Coeur d'Alene Wildlife Management Area, the concentrations are not high enough to pose a health threat due to the consumption of other tissues (Weston 1989). A study conducted by the Idaho Department of Fish and Game in August 1986 found that cadmium and lead were not detected in most duck breast tissue sampled even though both metals were detected in significant concentrations in kidney, liver, and bone. Similarly, zinc was detected in breast tissue at concentrations 50 to 90 percent lower than those in kidney, liver, and bone (Krieger 1990). Therefore, this pathway was not quantified in the HHRA.

For the subset of the population who hunt big game, there is a potential for metals exposure, particularly from white-tail deer who may spend an appreciable portion of their lives grazing in the floodplain of the lower Coeur d'Alene River. Unlike waterfowl, tissue data and other supporting studies are not available for any big game animals (one sample of white-tail deer muscle is all that is available). Two considerations may mitigate metals exposure from game: 1) divalent metals such as cadmium, lead and zinc are generally transported within the animal's body via the blood and stored or retained primarily in the spleen, kidney, bone, and liver, and 2) the big game catch limit of one or two animals per year would limit the amount of organ meat any one family could eat. Tissues normally eaten by hunters, primarily muscle and fat, contain lower concentrations of metal than the bones and organs (Benson et al.1976). However, "lower concentrations in tissue" may still have health impacts depending on the actual concentrations. In the absence of data, this pathway has not been quantified in the risk assessment and remains a source of uncertainty. This pathway is further discussed in Section 7.

Ingestion of Wild Plants Harvested From Floodplain

Three main types of plants are reportedly gathered from the floodplain area: berries, wild rice, and water potatoes. Uptake of metals by plants is minimal, indicating exposures due to their consumption would also be low. Except for cadmium, these metals do not tend to bioaccumulate in plant tissue (Nwosu, Harding, and Linder 1995). For example, the recommended root uptake factors (ratio of concentration in plant tissue to the concentration in the soil) for arsenic, cadmium, lead, and mercury are 0.0004, 0.04, 0.002, and 0.05, respectively (CalEPA 1996). However, other studies have shown that concentrations of cadmium in some plant tissues are higher than those in surrounding soils (Nwosu, Harding, and Linder 1995). Furthermore, the general population is not expected to eat a significant quantity of these plants. Therefore, this pathway was not quantified for the general population in the HHRA. The ingestion of water potatoes was quantified for subsistence exposures.

Concentrations of metals in wild plants will likely be small in comparison to concentrations in soil and/or sediments that might be directly ingested and when compared with other homegrown food items. The direct ingestion of soil and sediment and the ingestion of homegrown vegetables were quantitatively evaluated and risks from eating wild plants will be insignificant when compared to the risks from these pathways.

3.2.3 Complete Pathways Selected for Quantification

Ingestion of and Dermal Contact With Soil

Affected soil is the primary medium with which residents, neighborhood recreational residents, public recreational visitors, and workers are likely to come into contact. Therefore, exposure by incidental ingestion is likely and was quantified in the HHRA. This same affected soil is a primary source of indoor dust in residences. The contribution of indoor dust to risk was evaluated and is discussed qualitatively in this assessment for the non-lead metals. Indoor dust exposures are quantified for lead.

In general, metals in soil are strongly adsorbed and will not leach except under strongly acidic conditions. Soil-water partition coefficients (ratio of concentration in soil to concentration in water when both are available) for metals in the Basin range from 25 to 900, indicating that the metals are strongly adsorbed to soil (RAIS 1999). Therefore, absorption of metals through the skin is probably very slow.

Although dermal absorption of metals in soil through the skin is a complete pathway, available data indicate that the contribution of dermal soil exposure to overall risk is typically small (USEPA 1995b, 1996a). Furthermore, data on the amount of metals in soil absorbed through the skin is extremely limited (USEPA 1992a). However, dermal absorption of metals through the skin was quantified for arsenic and cadmium only, for which limited skin absorption data exist (USEPA 1998e, 1999c). In addition, these metals are more mobile in the environment than other metals because cadmium is soluble in water and arsenic has multiple oxidation states (USEPA 1985).

Ingestion of Tap Water

Metals have been detected in tap water at several locations. Ingestion of tap water is a significant source of intake into the body, so this pathway was included wherever residents or recreational visitors may have access to water containing mining-related chemicals. Only arsenic exceeded conservative screening criteria protective of human health. Therefore, of the non-lead metals, only arsenic was evaluated for the tap water ingestion pathway. Lead in tap water was evaluated quantitatively because the risk assessment for lead utilized the EPA IEUBK lead model which attempts to account for all sources of lead in the environment, not just sources with concentrations that exceed SVs.

Ingestion of Surface Water

Surface water in the Basin has been found to contain mining-related chemicals. Contact with surface water may result in exposure via incidental ingestion and dermal absorption (qualitatively evaluated). This is most likely to occur at sites where access to water is easy and attractive, such as developed or undeveloped beaches along the Coeur d'Alene River west of Cataldo. At these sites, recreational visitors or local residents may be exposed to contaminants in surface water while playing in the water. This is of particular concern where play in shallow water may disturb sediments and suspend them in the water column. In such cases, incidental ingestion of surface water containing suspended sediments may result in a significant dose. This pathway was quantified in the HHRA.

There are residents with ready access to affected surface water within neighborhoods that lack beaches or other amenities to attract visitors from beyond the immediate area. For example, children living close to Canyon Creek or Nine Mile Creek may play in the water near their homes. This may produce significant incremental doses; therefore, this pathway was included in the residential scenario at some locations (see Table 3-19a).

Ingestion of and Dermal Contact With Sediment

Ingestion of and dermal contact with sediment is likely to occur in the same situations as ingestion of surface water, as discussed in previous subsections. Sediment is defined as material transported by surface water and deposited along the banks of surface water bodies. Sediment includes the sand found at beaches, which may be above or below the water line. Sediments below the water line were evaluated in the surface water pathways described in the previous subsection, since they may be resuspended in the water column. Sediment above the water line may produce exposure through contact-intensive activities such as digging in beach sand. At beaches, the combination of exposed skin surface area and wet media may cause stronger adherence of sediments to the skin (Kissel et al. 1996a, 1996b, 1998; Holmes et al. 1999). This may lead to higher rates of incidental ingestion and prolonged dermal contact, so these pathways were quantified in the HHRA. As with soil, dermal contact was evaluated only for arsenic and cadmium (USEPA 1998e, 1999c). Exposure pathways for sediment were evaluated for the public recreational individual type and for appropriate residential neighborhood recreational receptor types.

Ingestion of Homegrown Vegetables

Consumption of garden vegetables was evaluated quantitatively. Currently, residents in the Basin grow and consume garden vegetables from yards that may contain mining-related chemicals. If either leafy (e.g., lettuce or cabbage) or below ground (e.g., radishes, beets, or carrots) produce was present at homes with vegetable gardens, a sample of the plant tissue was collected and analyzed for metals. These vegetable data were used to quantitatively evaluate exposures to metals via the ingestion of homegrown produce.

3.2.4 Potential Coeur d'Alene Tribal Pathways Selected for Quantification

Soil/sediment

The Coeur d'Alene made their homes largely in the floodplain in structures with soil floors covered with natural materials such as animal skins or woven mats. As a result, intense contact with soil and sediment would have occurred throughout the year in nearly all activities. The mat lodge, the basic structure for lodging, was rarely found anyplace but in the Lake Basin (Sprague 1999). Additionally, a variety of cultural activities would have resulted from increased soil and sediment exposure. These activities include children's games, vision quests, burials, and dances.

Children played various games involving strength and skill such as running, throwing balls and sticks, and shooting toy bows and arrows.

The vision quest involves long trips into remote areas. The activities of a person on a vision quest were to show evidence of being at a specific quest site and to tire oneself to become more susceptible to the spirit. The vision quest still has religious importance today.

"The Coeur d'Alene disposed of their dead by burial in the earth or in rock slides" (Ray 1942:237). The modern, Plateau-wide practice of each tribal member throwing in a shovel or hand-full of dirt into a new grave is reported as early as 1853.

Dances were largely for preparing for war or upon returning from war, spirit dances of individuals during the winter ceremonies, and social dances involving courtship (Teit 1930:186; Ray 1942:253). All of this activity normally took place in the floodplain of the Basin.

Surface Water

For the Coeur d'Alene, the number of activities taking place in the water are almost as extensive as the time spent on land, so the incidental ingestion of surface water could contribute substantially to exposure.

While fishing, a good portion of time was spent in the water. The following standard fishing techniques were employed by the Coeur d'Alene (Teit 1930:105-107; Ray 1942:104-116; for illustrations Walker 1967): the spear (harpoon and leister types), gaff, dip net, and hook and line. Other fishing techniques more akin to gathering were traps, weirs, dams, and nets. The weirs were a community effort and various ceremonies accompanied the construction. It involved long periods of time in shoulder high water; women bore the major brunt of the time in the water.

The Coeur d'Alene were well known for killing large groups of deer in Coeur d'Alene Lake. If one trait in hunting separates the Coeur d'Alene from the other Plateau groups it is their ability to drive deer into the Lake and dispatch them in the Lake from canoes by spearing, shooting with arrows, clubbing, or drowning by holding the head underwater by the antlers or with a crooked stick. The Coeur d'Alene would also do the same to elk, moose, and bear (Teit 1930:101).

Beavers were hunted by destroying the dam or swimming into the beaver house and then clubbing them to death. Attacking the beaver by way of the water was limited in the southern Plateau to only the Coeur d'Alene (Ray 1942:119).

One water plant important to the Coeur d'Alene and not found among many other Plateau peoples, was the water potato. It grows in soft mud underwater and is collected by several methods, the most common being digging underwater with the hands or a forked stick.

A pregnant mother was encouraged to bathe frequently for an easy birth. At birth, the newborn was bathed immediately (Ray 1942:194, 196).

The specific importance of water in puberty was expressed: "The old people made boys and girls bathe in cold water every day. This was to make them strong, hardy, and able to endure cold. It was also believed to make them healthy, immune from colds and sickness, and able to recover quickly from wounds” (Teit 1930:168-169). Vision quest sites were often near bodies of water because diving in water was expected to help tire the individual (Ray 1942:236).

The Coeur d'Alene disposed of their dead by burial. Prior to burial, they would wash the body and wrap it in a robe, skins, or especially tule mats. People involved in the burial process were purified by fasting and would “bathe themselves in running water" (Teit 1930:174); their clothes were also purified by being "immersed in stream or lake overnight" (Ray 1942:220-221).

Games of athletic skill, especially swimming and canoe racing were popular (Ray 1942:185). All people could swim; the arms were worked in a dog-like fashion, and they struck out with the right foot. Nearly all the men could dive, and some men could dive across St. Joe River (Teit 1930:134). The Coeur d’Alene also participated in the popular sports of canoe racing and tipping (Kowrach and Connolly 1990:56, 198).

Curing by shamans involved water and included the sequence of hand washing, blowing on the water, throwing the used water out, obtaining more, and then sprinkling it on the patient. The patients hands were also immersed in water as part of the cure. The use of water in Coeur d'Alene curing exceeds that of all other Plateau groups (Ray 1942:242-243).

Groundwater Seeps/Spring Water

Because spring and small stream water was universally preferred to major river and lake water for drinking by Plateau peoples; this would be the expected source for drinking water. According to Ray, water was consumed prior to eating any food at feasts (Ray 1942:133). The numerous activities discussed under the surface water pathway could, under some conditions, be practiced in seep and spring water and result in the ingestion of water.

Steam (sweating)

Although only the dermal and inhalation pathways are considered in the sweat bath discussion, sweat bathing was done immediately prior to plunging in cold water, either surface water or spring water.

Sweat houses were the typical Plateau domed type made of willows covered with sod. They tended to be small by Plateau standards, holding only one or two people or up to six (Ray

1942:181; George 1938). They were always located near fresh water that provided the source for the cold water plunge.

Sweating was for cleanliness, curing, and purification such as before hunting, after a burial, or after a battle (Ray 1942:123, 127). Children were expected, under threat of whipping, to sweat and plunge in cold water every day of the year. The daily sweat could be individual but it often was also an important social activity where the two sexes were separated and could discuss the events of the day. The Coeur d'Alene are also unusual in that they have both the sweat house and a pool of water heated with rocks, a combination of traits not common in the Plateau (Ray 1942:181-182). The sweat bath is still very much a part of Coeur d'Alene culture.

Biota - Fish

The importance of various food types for the Coeur d'Alene was the same as for other Plateau groups, with fish and roots as the primary source and meat from hunting as the third source. Meat and fish were cooked by roasting when fresh and usually boiled if dried. Not only was fish tissue consumed, but other parts of the fish including skin, scales, bones, viscera, eggs, and head. Some Native Americans have traditionally eaten the bones and organs as well (Walker and Pritchard 1999:50).

Fish caught in Coeur d'Alene Lake or the rivers were dried and smoked in the normal Plateau manner. Fish would be collected locally or brought back from fishing or trading from all of the Plateau fishing centers including Kettle Falls, The Dalles-Celilo, and lesser known locations such as the Upper reaches of the North Fork of the Clearwater River and the Snake River at the mouth of the Palouse River at Palus Village. These trading adventures were more typical of young men and were as much a social activity as they were for fish. Such trading also gave the Coeur d'Alene a wider range of fish varieties, especially for some of the salmon varieties that were richer in oil. Dried fish were traded largely from the Spokane and to a lesser extent from the Palus (Teit 1930:112-113).

The Coeur d'Alene fishing territory extended from the North Fork of the Clearwater River to the southern margin to Lake Pend Oreille and included Coeur d'Alene Lake and its major tributaries - the Coeur d'Alene, St. Joe and St. Maries Rivers - the upper portion of the Spokane River to Spokane Falls, Latah (Hangman) Creek, and the headwaters of the Palouse River (Scholz et al. 1985:40).

Other sources of food from the water included the pond turtle, frogs, and crayfish. All of these are still used today. The fish in the diet of modern Coeur d'Alene is extensive but a large portion of the fish comes from the Columbia River system.

Biota - Water Potato

As previously mentioned, the water potato was an important plant to the Coeur d’Alene. Also known as the wapato on the lower Columbia River, it was collected the last week of October through November along the shore of Chatcolet, Hayden, and Harrison lakes; it was also historically collected in the floodplain of the Coeur d’Alene River Basin (Palmer 1993:17). The Tribe continues to harvest water potatoes during the last week of October through November in the wetlands of Benewah and Chatcolet. In a specific study of the Coeur d'Alene water potato, it was reportedly collected at 91 different sites (Frey 1995). One Coeur d'Alene elder described the loss of this plant food due to the rising of Coeur d'Alene Lake and the subsequent pollution as one of the major psychological losses to the Coeur d'Alene people (Aripa pers. com. 1994). In preparing the water potato, the dark skin layer is often removed prior to boiling or baking; the narrow segment of the taproot (tail) is left attached if possible for added flavor (Frey pers. com. 2000).

Biota - Other Vegetation

The Coeur d’Alene Tribe utilized almost forty different species of plants from their territory for food, and others for their fibers or as dyes or medicines. Within traditional society, roughly one-third of the diet was comprised of roots and berries (Nugent 1997).

Roots harvested included 16 species with camas (*Camassia quamash*), bitterroot (*Lewisia redivia*), and kouse (*Lomatium* sp.) as the most important. In the early spring (April through May), the Coeur d’Alene moved to higher elevations to the berry, camas, and kouse areas. The area of Chatcolet Lake was once an excellent source of camas before it was inundated through the construction of the Post Falls dam. "The plant [camas] was so plentiful in many places that it is no exaggeration to say that in the upper St. Maries Basin more than one-half of the total herbaceous vegetation in the lowlands was composed of this one species" (Leiberg 1897:37).

Of the approximate 22 species of berries that were utilized, all but one of which grew in Coeur d'Alene territory, most grew in the mountains to the east (Teit 1930:90). Two species of lichens *Bryoria fremontii* and *Alectoria sarmentosa,* were collected and eaten by the Coeur d'Alene. Both are extremely plentiful at all elevations.

Stocks, seeds, and berries were collected, some berries could be shaken off, and others were combed. Roots were dug with digging sticks of the typical Plateau design, a slightly curved stick about four feet in length with a transverse elk antler handle less than a foot in length. Digging stick was used for all kinds of digging including graves and cooking ovens. After contact with settlers, the digging stick was iron (Teit 1930:91; Ray 1942:145). Berries were dried and strung or made into cakes. Root crops were cooked in earth ovens, usually without adding water for steam.

Biota - Animal Protein

The most important game animals were deer and elk in Coeur d'Alene territory. Other game of minor importance were moose, mountain goat, big horn sheep, bear, and beaver. Hunting of game included all of the usual Plateau techniques such as ambushes, blinds, screens, deer fences, driving, chasing, running with dogs, and using any number of techniques in the water (as mentioned previously) or combinations of these (Point 1967:178, 180).

Bears were also killed with dead falls. The hunting of grizzly bears is rarely mentioned in historical sources, but Kowrach and Connolly devoted several pages to a discussion of this dangerous activity (Kowrach and Connolly 1990:37-40). The dangerous method of thrusting a bi-pointed bone or stick in the open mouth of a bear was known to the Coeur d'Alene (Ray 1942:123).

Biota - Upland Birds/Water Fowl

Snares were used for upland, large birds such as grouse (Ray 1942:120). Doves were plentiful and shot or snared. Important small game included numerous local and migratory water fowl. Ducks were caught with hook and line baited with fish. Water fowl were shot from blinds either on land or canoes (Ray 1942:122). Small game also included "eagles, hawks, and woodpeckers for their feather" (Teit 1930:96). Eagles were caught in the typical fashion of hiding under a screen, often in wet areas, and reaching up and grabbing the eagle by the feet (Ray 1942:121).

Biota - Breast Milk

There are no data on breast feeding for the traditional Coeur d'Alene. The leading ethnologist for the Spokane, a Salish group very close culturally to the Coeur d'Alene, states that "at 1½ to 2½-years-of-age a child was weaned and encourage to walk" (Ross pers. com. 2000). For the Flathead, also a Salish speaking group to the east, Turney-High says that "children were not weaned until they were three years old. Spoiled children might not be weaned even at that time" (Turney-High 1937:72). The same author says that Kuteani "children were weaned at two at the very limit" (Turney-High 1941:114).

Traditional and Current Subsistence Exposure Routes

Table 3-19b shows those exposure routes that will be considered either quantitatively or qualitatively in the HHRA for the Tribal pathways.

Fully addressing the Native American exposures within the CDAB requires consideration of additional chemicals and routes of exposure not included in other scenarios in the HHRA. The resident riparian lifestyle in the Traditional Subsistence scenario and the harvest techniques employed throughout tribal history suggest that dermal exposure routes may be more significant than those applied to recreational scenarios for other populations. The tribal riparian lifestyle has the potential for significant prolonged dermal exposures to both sediment and water. One example of this type could be the harvest of the water potato (*Sagittaria spp.*) within the mouth of the Coeur d’Alene River. These activities also involve women of reproductive age accompanied by small children for extended periods of time.

Tribal consumption rates show that traditionally as much as one-third of the overall diet was resident fish. This substantial contribution to the diet requires reexamination of mercury levels in resident fish in assessing the Traditional Subsistence scenario.

The same exposure routes will be evaluated for the Traditional Subsistence scenario and the Current Subsistence scenario. For evaluation of the human health risks associated with each scenario, the exposure factors will reflect the difference for each exposure route. Generally, the exposure frequency, i.e. a shorter period of time, for the Current Subsistence are reduced from the values used in the Traditional Subsistence scenario.

The exposure factors to be quantified in the tribal scenarios for the human health risk assessment are:

- incidental ingestion of soil/sediment,
- dermal contact with soil/sediment,
- incidental ingestion of surface water during recreational activities,
- ingestion of surface water as the main drinking water source,
- consumption of fish, and
- consumption of water potatoes.

The remainder of the tribal pathways discussed in Section 3.2.4 will not be quantified in this risk assessment, due to limitations on available data or relative significance to contribute to the overall risk to human health. Data associated with certain exposure routes may be available, but it is considered insufficient to characterize media contaminant levels. Therefore, hazards and risks displayed in Sections 5.3.4 and 6.6.4 are judged to be conservative and not reflective of all possible exposure factors. Example calculations also showed these pathways do not significantly contribute to human health risk when compared to those pathways being quantified.

3.2.5 Complete Exposure Pathways Quantified by Area

Figures 3-3 through 3-11 present the potentially complete exposure pathways that were considered in this baseline HHRA. Potentially complete exposure pathways that were quantified are noted with a closed circle while those that were potentially complete but not quantified are noted with an open circle. Blank cells indicate that the pathway was not complete or that the receptor type does not exist in the particular area. Table 3-19a summarizes the exposure pathways that have been quantified for each exposure area.

3.3 QUANTIFICATION OF EXPOSURE TO NON-LEAD CHEMICALS

This section defines the magnitude, frequency, and duration of exposure for the populations and exposure pathways selected for quantitative evaluation. This evaluation is conducted in two stages: (1) estimation of exposure point concentrations (EPCs), and (2) quantification of pathway-specific intakes. Intakes are calculated for both the reasonable maximum exposure (RME) and a central tendency (CT) exposure.

The RME is the maximum exposure that is reasonably expected to occur at a site. Intake parameter values have been selected so that the combination of all parameters results in an estimate of the RME for a particular exposure pathway. By design, the estimated RME is higher than that expected to be experienced by most of the exposed population.

As recommended in EPA's *Guidance for Risk Characterization* (USEPA 1995d), CT exposure estimates represent the central estimates of exposure or dose. The CT exposure estimate is intended to be more representative of likely human exposures.

3.3.1 Exposure Point Concentrations

To calculate a cancer risk or a noncancer hazard, an estimate must be made of the chemical concentration to which an individual may be exposed. According to the EPA (USEPA 1991a, 1992c), the concentration term (or EPC) should be an estimate of the average concentration to which an individual would be exposed over a significant portion of a lifetime. Because of the uncertainty associated with estimating the true average concentration at a site, the EPA recommends the use of the 95 percent upper confidence limit (UCL_{95}) of the mean as the appropriate estimate of the average site concentration for an RME scenario (USEPA 1991a, 1992d, 1993c). At the UCL_{95}, the probability of underestimating the true mean is less than 5 percent. The UCL_{95} can address the uncertainties surrounding a distribution average due to limited sampling data. The locations of nonresidential soil, sediment, surface water, and groundwater sampling used in calculating EPCs are shown in Figures 3-12 through 3-26. These Figures display the sampling locations within the areas defined in Figure 3-1a. Residential sampling locations are not shown on these figures because of confidentiality agreements with homeowners.

A UCL_{95} was calculated if the number of samples evaluated was greater than or equal to 10 for a particular chemical. For data sets with fewer than 10 samples, the maximum concentration was selected as a health-protective estimate of exposure, since statistical evaluations are generally not meaningful if the sample size is less than 10. (For the screening level risk assessment for Coeur d'Alene Lake (Appendix B), UCL_{95} values were calculated for sample sizes of seven and greater. Seven samples were considered sufficient for each location based on the assumption that the sampled medium was relatively homogenous, a reasonable assumption for beach sediment deposited from upstream sources. The EPCs calculated for the HHRA were not all for relatively homogenous materials from the same source; consequently, calculations of UCL_{95} were only completed for sample populations of 10 or more.)

For the concentration term under the CT scenario, the mean of the sample data was used to represent an EPC (USEPA 1992d).

A complete listing of data used to calculate EPCs is presented in Appendix E. For nondetections, concentrations of half the detection limit were used in the EPC calculations. The Part D Table 3 series in Appendix A provides a summary of data including the EPCs for each exposure medium;

detailed statistics are included in Appendixes F and G for each medium and geographical location. Appendix F provides a detailed summary of the statistical results from the MTCA*Stat v2.1* applications (e.g., distribution tests, arithmetic means, maximum and minimum concentrations, and histograms) and includes the data used to calculate each EPC. All the data summarized in the Part D Table 3 series are from the information in Appendix F, with the exception of the UCL_{95} values for data lognormal distribution and data with neither a lognormal nor a normal distribution. Appendix G provides the SYSTAT *v.9* bootstrap exports used to calculate the RME UCL_{95} values for data with a lognormal distribution and data that were neither lognormal nor normal.

Calculation of RME Exposure Point Concentrations

The formula used to calculate a UCL_{95} depends on the distribution of the data, i.e., the "shape" of the curve (USEPA 1992d). EPA experience shows that most environmental contaminant data sets have a lognormal distribution (USEPA 1992d). However, in cases where the distribution is questionable or unknown, the EPA recommends (1) performing a statistical test to determine the best distribution assumption for the data set, and (2) graphing the data. Statistical tests or graphs (only for data sets with greater than 500 samples) were used to determine the distribution for all data sets with 10 or more samples. The results of the statistical tests and the graphs are included in Appendix F.

The Model Toxics Control Act (MTCA) statistical add-in to Microsoft Excel (MTCA*Stat v2.1*) provided by the Washington State Department of Ecology (Ecology) was used to determine distributions and calculate corresponding UCL_{95} values. The Shapiro-Wilk W-test for sample sizes less than or equal to 50, or D'Agostino's test (D-test) for sample sizes greater than 50, was performed on each data set. These tests determine if the data set best matches a normal, lognormal, or neither distribution (WDOE 1992; USEPA 1992d). The W-test and D-test are described in further detail in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987) and in *Statistical Guidance for Ecology Site Managers* (WDOE 1992).

If the result of a distribution test indicated a normally distributed data set, a normal UCL_{95} was calculated using MTCA*Stat v2.1* with an equation reflecting a Student's t-distribution as described in EPA guidance (USEPA 1992d). If the MTCA*Stat v2.1* results indicated a lognormal distribution of the data set, a one-sided UCL_{95} was calculated using the bootstrap method as recommended by the EPA (USEPA 1997b) based on CV, skewness, and sample size, as described in the following paragraph. The bootstrap exports are included in Appendix F. This particular method also applied to data sets where both the normal and lognormal assumptions of the distribution were rejected.

The bootstrap method is a nonparametric statistical technique, which can reduce the bias of point estimates and construct approximate confidence intervals for the population mean. This approach makes no assumptions regarding the distribution for the underlying population. EPA's technical issue paper recommending the bootstrap procedure under certain circumstances (USEPA 1997b) focused primarily on the problems associated with calculating a UCL_{95} when the distribution of the contaminant concentration appears to be highly skewed. Positively skewed distributions are usually modeled by the lognormal distribution. However, this skewness is possibly due to biased sampling, multiple populations, or outliers and is not necessarily due to lognormally distributed data (USEPA 1997b). Statisticians showed that incorrectly assuming a lognormal distribution may lead to erroneous results (Gilbert 1993; Stewart 1994). After presenting several simulated examples in its issue paper (USEPA 1997b), the EPA concluded that the use of several other methods (e.g., jackknife, bootstrap, and the Central Limit Theorem) is more accurate than the H-statistic UCL_{95} (lognormal UCL_{95} calculation previously recommended by USEPA 1992d). Therefore, the bootstrap method was chosen. The bootstrap procedure is discussed in further detail in *The Jackknife, the Bootstrap, and Other Resampling Plans* (Efron 1982).

Using SYSTAT *v.9* software, the bootstrap procedure involves drawing repeated samples of size *n* with replacement from the given set of data. The process is repeated many times and each time an estimate of the sample mean is calculated. For this baseline HHRA, the process was repeated 250 to 500 times depending on the sample size *n*. Even with 2,000 repetitions of the process, the estimate of the UCL_{95} was reasonably similar to the UCL_{95} calculated with fewer repetitions. (Test runs were conducted using 2,000, 1,000, 500, and 250 repetitions and the resulting UCL_{95} estimates were not substantially different from each other.) Subsequently, the bootstrapped estimates of the mean are ranked, the ranks are converted to percentiles, and the first estimate of the mean closest to the 95th percentile is used as the UCL_{95} (the RME Medium EPC Value–see Appendix A). Results of the bootstrap estimates are provided in Appendix G. Uncertainties associated with this procedure are discussed in Section 7.

Calculation of CT Exposure Point Concentrations

To calculate a central tendency exposure point concentration, USEPA 1992d recommends the use of the arithmetic mean no matter what the underlying distribution of the data set. However, more recent EPA studies state that for lognormally distributed data sets, an adjusted geometric mean is a more appropriate estimator of CT especially when the coefficient of variation is greater than one (USEPA 1997b). Most of the lognormally distributed data sets used to calculate EPCs in this HHRA had coefficients of variation larger than one (see Appendix F). Therefore, the geometric mean (from MTCA*Stat* export in Appendix F) multiplied by a “bias factor” is used to calculate the CT when the data is lognormally distributed (as recommended by Gilbert 1989 and Singh et al. 1997) and the arithmetic mean (the mean from MTCA*Stat* export in Appendix F) is used to calculate CT estimate of the EPC when the underlying distribution variance unbiased estimator (MVUE) of the mean, is calculated by the formula: lognormal mean = exp [geometric mean + (standard deviation^2/2)] (Gilbert 1987). The Table 3 series in Appendix A lists the distribution of the data and the CT values used in the HHRA as well as the arithmetic means of the data sets.

Exposure Point Concentrations by Medium

Table 3-20 summarizes the RME EPCs by medium (presented in detail in the Part D Table 3 series in Appendix A). The following subsections provide details on the data sets selected for each EPC, any data excluded from the calculations, and any unusual features of the particular data set. Table 3-21 summarizes the numbers of samples used for each EPC calculation in each human health exposure area.

Yard Soil EPCs. For the soil EPC, all soil samples collected in the 0- to 1-inch-depth interval of the homes in a particular geographical area were used. A separate residential soil EPC was calculated for each geographical area and Table 3-21 presents the numbers of homes and soil samples collected at the 0- to 1-inch depth for each of the eight residential areas. For example, the Kingston residential soil EPC is based on 71 samples collected from 22 homes.

Residential exposure to chemicals in soil may occur outside in the yard and inside the house since soil from the yard may be carried into the house. The default assumption in EPA's lead model is that, on average, 45 percent of a child's total intake of soil and dust is derived from outdoor soil and 55 percent is derived from indoor house dust (USEPA 1994a). Although some house dust concentrations of metals other than lead are available, the house dust data are insufficient to include directly in the EPC calculations for the non-lead metals. Of the 191 homes with soil data, only 83 homes had floor mat data (44 percent) and 74 homes had vacuum bag data (39 percent) for the nonlead metals. Therefore, only the data from yard soil were used to develop the residential soil EPCs, and yard soil concentrations served as surrogates for house dust concentrations. (Tables 3.1.1, 3.2.1, 3.3.1, 3.4.1, 3.5.1, 3.6.1, 3.8.1, and 3.9.1 in Appendix A provide the yard soil EPCs for each geographical area.) Using soil concentrations as surrogates for house dust concentrations has the potential to either underestimate or overestimate human health risks. The available house dust data is discussed in the following subsection and is further evaluated in Section 7.

House Dust Data. Two different types of house dust samples were collected: (1) floor mats placed just inside outer doors in the home, and (2) sample from vacuum cleaner bags.
Soil is assumed to be a major contributor to indoor concentrations of chemicals in dust. However, yard soil concentrations may be good predictors of some, but not all, chemical concentrations in dust. Additional sources of chemicals in dust (e.g., lead from paint as an additional lead source in dust) as well as differences in grain size between soil and dust may exist, resulting in enrichment or dilution of various chemicals in dust relative to soil. Depending on the chemical, either enrichment or dilution are indicated by the data. Soil samples were selected as a measure of dust concentrations for chemicals other than lead for the following reasons:

- There is a lack of sufficient dust data for each of the geographical subregions (dust samples were collected from homes that were volunteered for sampling, thus complete geographical coverage could not be attained).

- The uncertainties regarding the exact relationship between dust and soil concentrations for metals other than lead make predicting a house dust concentration from a soil concentration problematic.

Tap Water EPCs. The average of first-run and flushed-line tap water samples was calculated to arrive at one chemical concentration per home. The assumption that 50 percent of the water ingested is from the first-run sample is the default assumption in EPA's lead model (USEPA 1994a). The only non-lead COPC in tap water is arsenic; the arsenic concentrations in first-run and flushed-line samples were very similar. Fewer than 10 tap water samples were collected in five of the eight residential exposure areas (Table 3-21). In these areas, the maximum concentration (after averaging first-run and flushed-line) was selected as the EPC. (Tables 3.1.2, 3.2.2, 3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.8.2, and 3.9.2 in Appendix A provide the tap water EPCs for each geographical area.)

Total metal concentrations, rather than dissolved metal concentrations, were used for all water exposures, i.e., tap water, groundwater, and surface water.

Groundwater EPCs. All groundwater samples from wells drilled during source investigations in the Nine Mile/Canyon Creek area were used to calculate future drinking water EPCs. (Table 3.8.3 in Appendix A provides the groundwater EPCs for Nine Mile/Canyon Creek.)

Homegrown Vegetable EPCs. Homegrown produce data were collected from a wide variety of vegetables. Because the ingestion rates selected for vegetable consumption are based on total vegetable intake rather than categories of vegetables, all the vegetable data were pooled before calculating EPCs (see Table 3.11.1 in Appendix A).

Concentrations of metals in vegetables were reported as dry weight concentrations and the percent moisture content of the sample was reported separately. The wet weight concentration was used to calculate EPCs for the vegetable ingestion pathway because people generally do not remove the moisture from their produce before eating. The wet weight conversion from dry weight is as follows:

wet weight = (dry weight value)(100 ! % moisture/100)

Upland Soil EPCs. Sampled waste piles are present in the Nine Mile/Canyon Creek area and in the Mullan area. Waste piles are present in many other areas of the upper Coeur d'Alene Basin; however, in many cases the piles are not adjacent to residential homes (as is the case in the Nine Mile and Mullan areas) and sieved surface soil samples are not available because there were not enough fines in the top one inch of soil due to the rocky nature of waste piles. The available waste pile data are considered representative of this type of exposure throughout the Basin. (Tables 3.8.4 and 3.9.4 in Appendix A provide the waste pile EPCs for Nine Mile and Mullan.)

The public recreational soil areas are located in developed parks and ball fields in the upper Basin. The developed parks are located in the towns of Wallace and Silverton. Although samples up to a depth of 24 inches were collected in the upland parks, only the 0- to 1-inch-depth interval was used in the public recreational EPC calculations because surface soil has the greatest impact on exposure at these locations. (Tables 3.5.3 and 3.6.3 in Appendix A provide the upland parks EPCs for Silverton and Wallace.)

Floodplain Soil/Sediment EPCs. Sediment exposures are assumed to occur in the top 12 inches of sediment, the depth to which a child could be expected to dig in loose alluvial material. For the soil areas along the Coeur d'Alene River, where children might be exposed to surface soils during camping and picnicking, samples were collected over a depth interval of 0 to 1 inch and this interval was used in the EPC calculations for Coeur d'Alene River area soils. (Tables 3.1.3., 3.1.5, 3.2.3, 3.2.5, 3.3.3, 3.3.4, 3.4.3, 3.7.1, 3.8.5, 3.9.4, and 3.10.1 in Appendix A provide the floodplain soil/sediment EPCs.)

As described for public surface water EPCs, public areas of exposure to floodplain soil/sediment are all located along the lower Coeur d'Alene River. Exposed populations include neighborhood recreational groups as well as the general public.

Surface Water EPCs. Neighborhood recreational surface water exposures generally occur in the creeks, in the side canyons, and in the upper South Fork where there are no developed public park areas but residences are located adjacent to the water. (The South Fork has very few depositional areas within the river channel. Material in the channel consists mostly of gravel, pebbles, and cobbles. Thus, exposure to sediments containing mining-related metals is limited.) Surface water samples from various sampling events were segregated by geographical area. Table 3-3 presents the numbers of samples per area available for the EPC calculations. (Tables 3.1.4, 3.2.4, 3.2.6, 3.3.5, 3.7.2, 3.8.6, 3.9.5, and 3.10.2 in Appendix A provide the surface water EPCs.)

The water samples for neighborhood recreational exposures were collected without stirring up the sediment prior to sampling (as was done for public recreational water samples collected in the lower Coeur d'Alene River (Section 2.2.8). Therefore, water samples collected the neighborhood areas did not contain a high amount of suspended solids. Surface water samples from the lower Coeur d'Alene River, which were collected after purposeful disturbance of the water, contained suspended sediments.

Fish Tissue EPCs. Fish fillet data (wet weight concentrations) are available from three species of fish (perch, bullhead, and pike) from three of the lateral lakes along the lower Coeur d'Alene River. Separate EPCs were calculated for each species after pooling the data from the three lateral lakes (Medicine, Killarney, and Thompson) (see Table 3.11.2 in Appendix A). All fish fillet data are from one geographical area, the Lower Basin. The upper Basin has a very limited fish population and little fishing occurs. In addition, because of the high metals concentrations in sediments in the Lower Basin, the fish fillets in the lateral lakes likely represent somewhat of a worst case for human consumption for the public recreational exposure scenario.

As was previously discussed in Section 2.2.1, whole fish tissue data is not available for use in this human health risk assessment for the tribal scenarios. Whole body metal concentrations are usually higher than fillet concentrations; thus, use of fillet data for populations which consume whole fish (tribal subsistence scenarios) likely underestimates the chemical dose from fish. Whole body and fillet tissue samples were collected and analyzed for lead from the Spokane River for three species of fish (large-scale sucker, rainbow trout, and mountain whitefish) (Johnson 2000). EPCs were calculated for the Spokane River fillet data. If the same concentration increases apply to the species sampled in the lateral lakes, risk from fish ingestion would likely significantly increase if whole bodies are eaten rather than fillets.

Construction Site Soil EPCs. All soil data from all depth intervals in each applicable geographical area were used for the occupational EPC calculations for the construction worker scenario, with the exception of data from the waste piles. For occupational soil exposures in the Lower Basin, sediment data were also included because of the large floodplain area and the lack of easy differentiation between sediment and soil in the floodplain. (See Tables 3.1.7, 3.2.7, 3.7.3, 3.8.7, and 3.9.6 in Appendix A for construction site soil EPCs for each applicable geographical area.)

Water Potato EPCs. Separate water potato EPCs were calculated from peeled potatoes and from unpeeled potatoes. The Coeur d'Alene Tribe collected and analyzed water potatoes. Water potatoes were evaluated for non-lead metals (Table 3.1.6 in Appendix A) and lead (see Section 3.4).

3.3.2 Estimation of Chemical Intakes

As part of the exposure assessment, chemical intakes were determined for each pathway and population included in the quantitative risk assessment. In general, the intake of a chemical is estimated from exposure models that combine various exposure factors related to behavior and physiology, such as exposure frequency and duration, contact rate, chemical concentration, body weight, and averaging time. Chemical intake equations for each exposure pathway and medium are presented below. The equations and the selected intake parameters are presented in the Part D, Table 4 series, in Appendix A and are summarized in Tables 3-22 through 3-26. Exposure scenarios by geographical area are summarized in Table 3-19a.

Soil and Sediment

Two exposure pathways were evaluated for soil and sediment: incidental ingestion and dermal contact. Intake of chemicals through the incidental ingestion of soil or sediment was calculated as follows (see also Appendix A, Tables 4.1, 4.4, 4.5, 4.6, 4.8, 4.9, and 4.12):

$$\text{Chemical Intake} = C_s \times SIF_{s\text{-}ing} \quad (1)$$

$$SIF_{s\text{-}ing} = (IR \times EF \times ED \times CF \times ABS) / (BW \times AT) \quad (2)$$

where

C_s	=	Chemical concentration in soil or sediment (mg/kg)
$SIF_{s\text{-}ing}$	=	Summary intake factor for soil/sediment ingestion (kg/kg-day)
IR	=	Ingestion rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (kg/mg)
ABS	=	Gastrointestinal absorption
BW	=	Body weight (kg)
AT	=	Averaging time (days)

It was assumed that 100 percent of the soil and sediment ingested is from potentially contaminated areas of the site.

For residential and public recreational soil/sediment ingestion, risks were evaluated for both a child (age 0 to 6) and an integrated child/adult scenario (child age 0 to 6, adult age 7 to 30). The integrated child/adult scenario for soil/sediment ingestion was calculated as follows:

$$SIF_{s\text{-}ing} = [(IR_{ch} \times ED_{ch})/BW_{ch} + (IR_a \times ED_a) / BW_a] \times EF \times CF \times ABS / AT \quad (3)$$

where

$SIF_{s\text{-}ing}$	=	Summary intake factor for soil/sediment ingestion (kg/kg-day)
IR_{ch}	=	Child soil/sediment ingestion rate (g/day)
ED_{ch}	=	Child exposure duration (years)
BW_{ch}	=	Child body weight (kg)
IR_a	=	Adult soil/sediment ingestion rate (g/day)
ED_a	=	Adult exposure duration (years)
BW_a	=	Adult body weight (kg)
EF	=	Exposure frequency (days/year)
CF	=	Conversion factor (kg/mg)
ABS	=	Gastrointestinal absorption
AT	=	Averaging time (days)

Intake of chemicals through dermal contact with soil or sediment was calculated as follows:

$$\text{Absorbed Dose (mg/kg-day)} = C_s \times SIF_{s\text{-}derm} \qquad (4)$$

$$SIF_{s\text{-}derm} = SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT) \qquad (5)$$

where

C_s	=	Chemical concentration in soil/sediment (mg/kg)
$SIF_{s\text{-}derm}$	=	Summary intake factor for dermal contact with soil/sediment (kg/kg-day)
SA	=	Skin surface area available for contact (cm^2)
AF	=	Soil-to-skin adherence factor (mg/cm^2-event)
ABS	=	Chemical-specific dermal absorption factor (unitless)
EF	=	Exposure frequency (events/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

For residential and public recreational dermal contact scenarios, risks were evaluated for both a child (age 0 to 6) and an integrated child/adult scenario. The integrated child/adult scenario for dermal contact with soil/sediment was calculated as follows:

$$SIF_{s\text{-}derm} = [(SA_{ch} \times AF_{ch} \times ED_{ch}) / BW_{ch} + (SA_a \times AF_a \times ED_a) / BW_a] \times ABS \times EF \times CF / AT \qquad (6)$$

where

$SIF_{s\text{-}derm}$	=	Summary intake factor for dermal contact with soil/sediment (kg/kg-day)
SA_{ch}	=	Child skin surface area available for contact (cm^2)
AF_{ch}	=	Child soil-to-skin adherence factor (mg/cm^2-event)
ED_{ch}	=	Child exposure duration (years)
BW_{ch}	=	Child body weight (kg)
SA_a	=	Adult skin surface area available for contact (cm^2)

AF_a	=	Adult soil-to-skin adherence factor (mg/cm^2-event)
ED_a	=	Adult exposure duration (years)
BW_a	=	Adult body weight (kg)
ABS	=	Chemical-specific dermal absorption factor (unitless)
EF	=	Exposure frequency (events/year)
CF	=	Conversion factor (kg/mg)
AT	=	Averaging time (days)

Groundwater/Tap Water

Intake of chemicals through the ingestion of groundwater as a drinking water source was calculated as follows (see also Appendix A, Table 4.2):

$$\text{Chemical Intake (mg/kg-day)} = C_w \times SIF_w \tag{7}$$

$$SIF_w = IR_w \times EF \times ED \times CF / (BW \times AT) \tag{8}$$

where

C_w	=	Chemical concentration in groundwater/tap water (µg/L)
SIF_w	=	Summary intake factor for ingestion of tap water (L/kg-day)
IR_w	=	Ingestion rate of tap water (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (mg/µg)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Risks from tap water ingestion were evaluated for both a child (age 0 to 6) and an integrated child/adult scenario. The integrated child/adult scenario for tap water ingestion was calculated as follows:

$$SIF_w = [(IR_{ch} \times ED_{ch}) / BW_{ch} + (IR_a \times ED_a) / BW_a] \times EF \times CF / AT \tag{9}$$

where

SIF_w	=	Summary intake factor for ingestion of tap water (L/kg-day)
IR_{ch}	=	Child tap water ingestion rate (L/day)
ED_{ch}	=	Child exposure duration (years)
BW_{ch}	=	Child body weight (kg)
IR_a	=	Adult tap water ingestion rate (L/day)
ED_a	=	Adult exposure duration (years)
BW_a	=	Adult body weight (kg)
EF	=	Exposure frequency (days/year)
CF	=	Conversion factor (mg/µg)
AT	=	Averaging time (days)

Surface Water

Intake of chemicals through the incidental ingestion of surface water during swimming or wading was evaluated using the following equation (see also Appendix A, Tables 4.7 and 4.10):

$$\text{Chemical Intake (mg/kg-day)} = C_w \times SIF_{sw} \tag{10}$$

$$SIF_{sw} = IR_{sw} \times ET \times EF \times ED \times CF1 \times CF2 / (BW \times AT) \tag{11}$$

where

C_w	=	Chemical concentration in surface water (µg/L)
SIF_{sw}	=	Summary intake factor for incidental ingestion of surface water (mg-L/µg-kg-day)
IR_{sw}	=	Ingestion rate of surface water during swimming or wading (mL/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF1	=	Conversion factor (mg/µg)
CF2	=	Conversion factor (L/mL)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Risks from incidental surface water ingestion were evaluated for both a child (age 0 to 6) and an integrated child/adult scenario. The integrated child/adult scenario for surface water ingestion was calculated as follows:

$$SIF_{sw} = [(IR_{ch} \times ED_{ch}) / BW_{ch} + (IR_a \times ED_a) / BW_a] \times ET \times EF \times CF1 \times CF2 / AT \tag{12}$$

where

SIF_{sw}	=	Summary intake factor for incidental ingestion of surface water (L/kg-day)
IR_{ch}	=	Child surface water ingestion rate (mL/hour)
ED_{ch}	=	Child exposure duration (years)
BW_{ch}	=	Child body weight (kg)
IR_a	=	Adult surface water ingestion rate (mL/hour)
ED_a	=	Adult exposure duration (years)
BW_a	=	Adult body weight (kg)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
CF1	=	Conversion factor (mg/µg)
CF2	=	Conversion factor (L/mL)
AT	=	Averaging time (days)

Homegrown Vegetables

Intake of chemicals through the ingestion of homegrown vegetables was calculated as follows (see also Appendix A, Table 4.3):

$$\text{Chemical Intake (mg/kg-day)} = C_{veg} \times SIF_{veg} \quad (13)$$

$$SIF_{veg} = IR_{veg} \times EF \times ED \times CF / AT \quad (14)$$

where

C_{veg}	=	Chemical concentration in homegrown vegetables (mg/kg)
SIF_{veg}	=	Summary intake factor for ingestion of homegrown vegetables (kg/kg-day)
IR_{veg}	=	Intake rate of homegrown vegetables (g/kg-day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (kg/g)
AT	=	Averaging time (days)

Because the intake rate for homegrown vegetables is already normalized to body weight (i.e., the intake rate is presented as g/day per kg body weight), a separate intake calculation was not performed for children.

Fish

Intake of chemicals through the ingestion of recreationally caught fish was calculated for adults only (see Appendix A, Tables 4.11 and 4.13). The following equation was used:

$$\text{Chemical Intake (mg/kg-day)} = C_f \times SIF_f \quad (15)$$

$$SIF_f = IR_f \times EF \times ED \times CF / (BW \times AT) \quad (16)$$

where

C_f	=	Chemical concentration in fish tissue (mg/kg)
SIF_f	=	Summary intake factor for ingestion of fish (kg/kg-day)
IR_f	=	Intake rate of fish (g/kg-day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (kg/g)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

3.3.3 Exposure Factors

Exposure factors were identified for the RME and CT cases as described in the following subsections. The exposure factors were selected after a review of historical risk assessments associated with the Bunker Hill Superfund Site, EPA guidance documents, site-specific health studies, and professional judgement. The exposure factors used in this baseline HHRA are summarized in Tables 3-22 through 3-26.

General Exposure Factors

The following exposure factors are common to all the scenarios evaluated in this baseline HHRA.

Body Weight. An adult body weight of 70 kg was assumed. This is the average body weight for adult men and women combined, rounded to 70 kg (USEPA 1991a, 1991b). For children ages 0 to 6, an average body weight of 15 kg was assumed (USEPA 1991a, 1991b). For children ages 4 to 11, a value of 28 kg was used; this is the 50th percentile body weight for boys and girls combined (USEPA 1997a). Average body weights were used for both the RME and CT cases, because when combined with the other variables in the intake equation, it is believed to result in the most reasonable estimate of intake (USEPA 1989). For example, it would not be reasonable to assume that the smallest person would have the highest intake.

Exposure Duration. For RME residential and recreational exposures, an exposure duration of 30 years was assumed. This represents the 90th percentile for time spent at one residence (USEPA 1991a). Of the 30 years total exposure duration, it was assumed that a 6-year period (ages 0 to 6) accounts for the period of highest soil ingestion and lowest body weight. A 24-year duration was assessed for older children and adults (USEPA 1991a). For children ages 4 to 11, an exposure duration of 7 years (to cover the entire age range) was used. A construction worker was conservatively assumed to work for 25 years in the same area; this represents the 95th percentile for length of time that employees work in the same location, according to the Bureau of Labor Statistics (as cited in USEPA 1991a).

For the CT residential and recreational cases, an exposure duration of 9 years was assumed; this represents the 50th percentile for residence time at one location (USEPA 1991b). Of the 9 years total duration, 2 years was assumed for ages 0 to 6; an exposure duration of 7 years was assumed for older children and adults (USEPA 1993c). For children ages 4 to 11, a CT exposure duration of 2 years was assumed. For the construction worker, a CT exposure duration of 6.6 years was selected. This represents the median length of time a worker spends at one job (USEPA 1997a).

Averaging Time. For carcinogens, an averaging time of 70 years (equivalent to a lifetime) was used (USEPA 1989). For noncarcinogens, an averaging time equal to the exposure duration was used (USEPA 1989).

Dermal Absorption Factor. The dermal absorption factor represents the fraction of a chemical that is absorbed through the skin via contact with soil or sediment. Dermal absorption factors of 0.03 and 0.001 were assumed for arsenic and cadmium, respectively (USEPA 1998e).

Gastrointestinal Absorption Factor. The dose calculated by the exposure assessment is considered an "administered" or "applied" dose unless it is corrected for the extent of systemic absorption into the blood stream ("absorbed" dose). In general, when assessing exposure by a given route, the amount of absorption of chemicals should be adjusted if absorption for the population at risk differs from the population (human or laboratory animals) used to develop the relevant toxicity criteria (see Section 4). This discrepancy may result from differences in the administered form of the toxicant or from differences in physiological processes. A correction for gastrointestinal absorption via soil ingestion was considered appropriate only for arsenic, as discussed in the following paragraph.

Gastrointestinal absorption of ingested arsenic varies greatly with the water solubility of the arsenic compound and the physical form administered (USEPA 1984). For example, absorption of arsenic trioxide is reported to be 30 to 40 percent for the compound in suspension, but as high as 95 percent or greater for the compound in solution (Ariyoshi and Ikeda 1974; USEPA 1984). Because the toxicity criterion is based on inorganic arsenic dissolved in drinking water, an absorption correction should be considered for the differences between arsenic absorption from soil versus from drinking water. There is uncertainty associated with the bioavailability of arsenic in soil, differences in soil types, and the lack of human absorption data.

The correction factor used in this risk assessment is the EPA Region 10 default relative bioavailability factor of 60 percent (USEPA 2000b). This value was derived from the EPA Region 10 animal study in which immature swine were dosed with residential soil (80 percent) and slag dust (42 percent) from the smelter-impacted Ruston/North Tacoma Superfund site in Washington (USEPA 1996d). A site-specific gastrointestinal absorption factor for arsenic was derived from this study and the lower 95 percent confidence limit of that value has become the Region 10 default bioavailability factor; 60 percent (USEPA 2000b). The lower 95 percent confidence limit was used because it was assumed that the relative arsenic bioavailability would be lower for mining impacted soils than for smelter impacted soils due to the differences in arsenic particle size and arsenic species (USEPA 2000b). For a more detailed discussion of the bioavailability rate of arsenic, see Section 7.

Residential Exposure Factors

The residential exposure factors apply to exposures to yard soil, house dust, tap water, and homegrown vegetables by children (ages 0 to 6) and adults living in the human health exposure areas.

Soil and House Dust Ingestion Rate. For the RME case, a residential soil ingestion rate of 100 mg/day was selected for adults (USEPA 1991a; a soil ingestion rate of 200 mg/day was selected for children (USEPA 1991a). These ingestion rates account for ingestion of both outdoor soil and indoor dust and are believed to represent upperbound values for soil and dust ingestion; they are EPA's RME default values for residential soil ingestion (USEPA 1991a). For the CT case, a soil ingestion rate of 50 mg/day was assumed for adults who do not engage in activities with a lot of soil or dust contact on a regular basis (USEPA 1993c). For children, a soil ingestion rate of 100 mg/day was selected; this value was deemed to be reasonable based on results using tracer elements and is nearly identical to the ingestion rate for this age group based on age-specific values utilized in support of the NAAQC for lead and the lead biokinetic uptake model (USEPA 1993c).

Tap Water Ingestion Rate. An adult RME drinking water ingestion rate of 2 L/day was selected. This value is currently used by the EPA Office of Water in setting drinking water standards and is EPA's default RME adult drinking water ingestion rate (USEPA 1991a). For the CT case, an adult water ingestion rate of 1.4 L/day is based on the average intake observed from five studies as summarized in the *Exposure Factors Handbook* (USEPA 1997a) and is EPA's recommended value (USEPA 1991b, 1993c). For children, a drinking water ingestion rate of 1 L/day was used for both the RME and CT cases (USEPA 1999c).

Homegrown Vegetable Ingestion Rate. A wet-weight vegetable ingestion rate of 5.04 g per kg body weight per day (g/kg-day) for the RME case and 0.492 g/kg-day for the CT case were selected, based on the U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey (NFCS). The most recent data (1987-88) were used to generate intake rates for home-produced foods because they are believed to be reflective of current consumption patterns among the U.S. population. The NFCS collected information over a 7-day period on the socioeconomic and demographic characteristics of households, and the types, amounts, value, and sources of foods consumed by the household (USEPA 1997a). The sample size for the 1987-88 survey was approximately 4,300 households, consisting of over 10,000 individuals. The NFCS tabulated the percentage of total intake of each home-produced food item group consumed during the survey period. The percentage of homegrown vegetable intake was presented as the ratio of total intake of the homegrown vegetable to the total intake of all forms of food.

Percentiles of average daily intake derived from short-term intervals (e.g., 7 days) are generally not reflective of long-term patterns. For example, homegrown vegetables have a strong seasonal component associated with their use. The consumption rates are generally influenced by the following factors (USEPA 1997a):

- Size of garden,
- Yield,
- Quality of produce,
- Types of vegetables grown,
- Length of growing season, and
- Climate.

Therefore, an approach was developed that attempted to account for seasonal variability (e.g., climate and length of growing season) in consumption. Seasonally adjusted percentile distributions for a given region were calculated by averaging the corresponding percentiles of each of the four seasonal distributions of the region. When using regional seasonally adjusted distributions to approximate regional long-term distributions, it was assumed that each individual consumes at the same regional percentile level for each season and consumes at a constant weekly rate throughout a given season (USEPA 1997a).

For consumers in the West Region, the recommended seasonally adjusted 50th and 95th percentile vegetable intake rates are 0.492 g/kg-day and 5.04 g/kg-day, respectively (USEPA 1997a, Table 13-33). The use of these values in calculating chemical intake does not require the body weight factor to be included in the denominator of the daily intake equation. The reason is that the total survey population included children as well as adults and in addition to adult body weight and adult intake rates, child body weight and child intake rates were factored in to the overall ingestion rate. The average body weight for all participating age groups was approximately 60 kg.

In addition, it was assumed that the seasonally adjusted intake rates also include consumption of canned and frozen homegrown vegetables throughout the year. The intake rates were not adjusted for preparation losses (e.g., removal of skin, peel, core, caps, stems, and defects, or draining of liquids from canned or frozen forms (USEPA 1997a). Therefore, the homegrown vegetable ingestion rates are assumed to be health protective.

Exposure Frequency. The EPA default residential exposure frequency of 350 days/year was used for the RME residential case (USEPA 1991a). For CT exposures to yard soil, a residential exposure frequency of 260 days/year was used. This is based on the 1997 Exposure Frequency Handbook, Table 15A-3, "Time Spent in Various Microenvironments." The table lists the mean time spent at home for men and women as 62% and 71%, respectively. The more conservative 71% (260 days per year) time spent at home was selected as the CT exposure frequency for yard soil. For CT exposures to tap water, an exposure frequency of 234 days/year was assumed; this is the CT default value listed in USEPA 1993c. Because the vegetable ingestion rate is an average daily consumption rate, the appropriate exposure frequency for both the RME and the CT case is 365 days/year.

Skin Surface Area. For adults exposed to yard soil, a skin surface area of 2,500 cm^2 was selected; this represents an adult wearing a short-sleeved shirt, long pants, and shoes, with exposed skin surface limited to the face, hands, and forearms (USEPA 1998e). For child exposure to yard soil, a skin surface area of 2,200 cm^2 was selected; this represents the exposed area on a child wearing short-sleeved shirt and shorts, but no shoes; exposure is to head, hands, forearms, lower legs, and feet (USEPA 1998e).

Adherence Factor. Soil adherence factors of 0.1 and 0.2 were assumed for adults and children, respectively. These values are based on data reported by Kissel et al. (1996a, 1996b, 1998) and Holmes et al. (1999).

Neighborhood Recreational Exposure Factors

The neighborhood recreational exposure factors apply to local residents adjacent to mining-impacted rivers, creeks, waste piles, and parks/schools. The population of greatest concern for these exposures is assumed to be children ages 4 to 11; therefore, this is the receptor group that was evaluated for neighborhood recreational exposures.

Soil and Soil/Sediment Ingestion Rates. An RME soil/sediment ingestion rate of 300 mg/day was selected for children ages 4 to 11. This value represents the 90th percentile intake based on a soil and feces tracer study (van Wijnen et al. 1990, as cited in USEPA 1997a) that measured ingestion rates for 78 children at campgrounds. The “campground” intake rate is now considered by EPA Region 10 to be the appropriate ingestion rate for intermittent recreational exposures (USEPA 1999d). The mean value of soil intake from the same study, 120 mg/day, was selected as the soil and sediment ingestion rate for the CT case.

Surface Water Ingestion Rate. An incidental surface water ingestion rate of 30 mL/hour was selected; this value was used by the EPA to derive AWQC for human health (USEPA 1998d).

Exposure Time for Incidental Ingestion of Surface Water. An exposure time of 1 hour per event for incidental ingestion of water while swimming was assumed (USEPA 1997a, Table 15-176). This represents the 50th percentile value for swimming duration in a freshwater swimming pool. It is also EPA’s recommended value for assessing swimming activities (USEPA 1997a).

Exposure Frequency. For neighborhood recreational exposure to waste pile soil, it was assumed that children ages 4 to 11 would visit a waste pile once per week for 34 weeks (April through November) each year. The assumption of 34 weeks is based on professional judgement in consideration of weather conditions in the Basin and the historical divisions of the year from previous HHRAs conducted in the Bunker Hill Superfund site. Historically, 17 weeks of summer and 17 of spring and fall combined have been assumed for recreational exposures (Jacobs Engineering et al. 1989). In addition, it was assumed that the weekly exposure would occur over a 7-hour period; this is EPA’s recommended value for children’s weekend exposure outdoor time (USEPA 1997a).

For neighborhood recreational exposures to upland parks and schools, as well as upland soils in the Elk Creek area, it was assumed that children ages 4 to 11 would visit these locations two times per week for 34 weeks (April through November) each year.

For neighborhood recreational exposures to floodplain soil/sediment and surface water, an exposure frequency of four times per week for 24 weeks (May through mid-October) was assumed. In addition, it was assumed that exposures would occur for 3 hours per day for soil/sediment and 1 hour per day for surface water; these the upper and lower percentiles of the average time, respectively, spent at most outdoor activities (USEPA 1997a). These values are similar to the 2 hours/day and 3 hours/day “other” outdoor exposures used to represent summer exposures for age groups 2 through 6 years old and 7 through 12 years old, respectively (Jacobs Engineering et al. 1989).

Skin Surface Area. Because the creeks are generally too small for swimming, the body surface area available for contact with sediment at areas with no public access was assumed to be 5,080 cm^2 (assuming shorts, bare feet, and short-sleeved shirt for children 4 to 11 years old) (USEPA 1997a). For neighborhood exposures in the lower Coeur d’Alene River and the lateral lakes (i.e., Lower Basin and Kingston [NS confluence]) where swimming is possible, a skin surface area of 7,960 cm^2 was assumed. This value is based on the assumption that of the 24 weeks per year of exposure, swimming would occur during the warmest 16 weeks of the year (with a corresponding skin surface area of 9,400 cm^2, the median skin surface area for male children ages 4 to 11), whereas wading and playing along the shoreline (without swimming) would occur during 8 weeks of the year (with a corresponding skin surface area of 5,080 cm^2) (USEPA 1997a).

For exposure to soil at upland parks and schools, as well as in the vicinity of Elk Creek, a skin surface are of 5,080 cm^2 was selected. This represents shorts, bare feet, and short-sleeved shirts for children 4 to 11 years old (USEPA 1997a).

Adherence Factor. A soil adherence factor of 0.2 was assumed for neighborhood children engaged in recreational activities. This value is based on data reported by Kissel et al. (1996a, 1996b, 1998) and Holmes et al. (1999).

Public Recreational Exposure Factors

The public recreational exposure factors apply to children ages 0 to 6 and adults involved in recreational activities at public parks/schools and beaches.

Soil and Soil/Sediment Ingestion Rates. A soil/sediment ingestion rate of 300 mg/day was selected for children based on the study previously discussed for neighborhood soil/sediment ingestion rates (van Wijnen et al. 1990, as cited in USEPA 1997a). The adult residential default of 100 mg/day ingestion rate for soil/sediment was selected for public recreational exposures (USEPA 1991a).

Surface Water Ingestion Rate. An incidental surface water ingestion rate of 30 mL/hour was selected; this value was used by the EPA to derive AWQC for human health (USEPA 1998d).

Exposure Time for Incidental Ingestion of Surface Water. An exposure time of 1 hour per event for incidental ingestion of water while swimming was assumed (USEPA 1997a, Table 15-176). This represents the 50th percentile value for swimming duration in a freshwater swimming pool.

Ingestion Rate of Fish. A fish ingestion rate of 46 g/day was selected based on national fish portion sizes (USEPA 1997a) and information from a local fish consumption survey (ATSDR 1989). The Agency for Toxic Substances Disease Registry (ATSDR) performed a study in 1989 examining fish consumption in the Coeur d'Alene Basin. The survey encompassed three populations: members of the Coeur d'Alene Tribe, fishing license holders, and volunteers. Individuals were asked about the amount and type of locally caught fish they consumed. They also provided blood and urine samples for analysis of lead and cadmium. The survey results were reported as the number of meals with fish per week. Participants' answers were placed into the following categories: 0 meals per week; less than 1 meal per week; 1 to 2 meals per week; 3 to 6 meals per week; and 7 to 14 meals per week.

The largest percentage of volunteer and fishing license populations (approximately 70 percent and 74 percent, respectively) reported that they ate less than one fish meal per week. The second largest category (1 to 2 fish meals per week) consisted of 20 percent of volunteers and 16 percent of individuals with a fishing license. Approximately 78 percent of the tribal population reported that they ate 0 fish meals per week, while 12 percent reported eating 1 to 2 fish meals per week. The tribal population was the only group with a significant percentage (7 percent) in the highest category (7 to 14 meals per week).

In order to estimate a fish ingestion rate from the ATSDR survey data, an assumption was made about the amount of fish consumed per meal. The study reported the amount of fish eaten per meal and estimated portion size. The average portion size based on a dressed 8-inch trout for adult males and females was 252 grams.

Alternatively, the EPA (USEPA 1997a) recommends a 50th percentile fish portion size per meal of 129 and a 95th percentile portion size of 326 g per the general population. With one fish meal per week for the surveyed population and the 95th percentile portion size, the fish ingestion rate would be approximately 46 g/day (one meal per week x 326 g per meal/7 days per week). This value was used to represent the RME recreational fish consumption rate. The value of 25 g/day was used as the CT fish consumption rate. EPA's recommended ingestion rate for freshwater anglers is 25 g/day (USEPA 1997a).

Exposure Frequency. For upland soil exposures, the selected exposure frequency was twice per week for 8 months (April through November), or 34 weeks per year. Exposure was assumed to occur over a 7-hour period for each event, based on the recommended children's weekend outdoor exposure time (USEPA 1997a).

Recreational exposure frequencies of 32 days per year for beach sediment and surface water exposures were assumed for public access beaches, based on 2 days per week from June through September. This exposure frequency was also selected for the expedited screening level risk assessment for common use areas surrounding Coeur d'Alene Lake, with input from state, local, and tribal agencies (Appendix B).

Skin Surface Area. For adults exposed to soil at upland parks and schools, a skin surface area of 2,500 cm^2 was selected; this represents an adult wearing a short-sleeved shirt, with exposed skin surface limited to face, hands, and forearms (USEPA 1998e). For child exposure to soil at upland parks and schools, a skin surface area of 2,200 cm^2 was selected; this represents a child (age 0 to 6) wearing a short-sleeved shirt and shorts, but no shoes; exposure is to head, hands, forearms, lower legs, and feet (USEPA 1998e).

For exposures to soil and sediment at public beaches, exposure of the entire body was assumed; this corresponds to 18,000 cm^2 for adults and 6,500 cm^2 for children ages 0 to 6 (USEPA 1998e).

Adherence Factor. Soil/sediment adherence factors of 0.1 and 0.2 were assumed for adults and children, respectively. These values are based on data reported by Kissel et al. (1996a, 1996b, 1998) and Holmes et al. (1999).

Occupational Exposure Factors

Occupational exposure factors apply to construction workers and other workers who have more exposure than the average adult.

Soil Ingestion Rate. An RME soil ingestion rate of 300 mg/day for a construction worker was selected. This value is for an adult occupational exposure scenario with extensive soil contact; it is based primarily on the work of van Wijnen et al. (1990). However, the van Wijnen et al. study involved a 3- to 5-day exposure of children staying at campgrounds with the objective of maximizing the possibility of direct contact with soil. According to recent EPA Region 10 guidance (USEPA 1999d), adults in activities involving direct contact with soil would be unlikely to have soil ingestion rates greater than those of the children in this short-duration study. A recent work by Stanek et al. (1991), provides an upper percentile ingestion rate of about 300 mg/day for adults over a 4-week period while engaged in routine day-to-day activities. This estimate, as stated by the authors, is highly uncertain due to the small size of the study. Although the estimate is uncertain, the Stanek report provides evidence that adults can have soil ingestion rates in the magnitude of 300 mg/day. Adults in activities involving direct contact with soil would be unlikely to have soil ingestion rates lower than the upper percentile shown in this long-term study of adults in day-to-day activities, which may include occasional activities requiring direct soil contact (USEPA 1999d).

For the CT case, a soil ingestion rate of 200 mg/day was assumed. This represents the recommended value for adult occupational soil ingestion in a soil contact exposure scenario.

Exposure Frequency. An RME exposure frequency of 195 working days per year (5 days per week for 39 weeks) was assumed for the construction worker. This is equivalent to a 9-month construction season (March to November, excluding 3 months for snow cover). For the CT case, an exposure frequency of 43 days per year was assumed (5 days per week for 8.7 weeks). This is equivalent to a 2-month construction project, the assumed length of time for soil contact-intensive activities related to the construction of a housing subdivision or commercial structure.

Skin Surface Area. Exposed skin surface area for a construction worker was assumed to be 2,500 cm^2; this corresponds to exposure to face, forearms, and hands (USEPA 1998e).

Adherence Factor. A soil adherence factor of 0.1 was assumed for construction workers. This value is based on data for gardeners reported by Kissel et al. (1996a, 1996b, and 1998) and Holmes et al. (1999).

Traditional Tribal Subsistence Exposure Factors

Both the traditional subsistence and current subsistence lifestyles have been characterized, and appropriate tribal exposure factors and consumption rates have been developed. Generally, the various tribal exposure pathways and consumption rates included for use by the Coeur d'Alene Tribe were originally developed from research conducted with the Umatilla Tribe in Northeastern Oregon (Harris and Harper 1997). The results of that research were subsequently utilized within the Hanford Screening Assessment under a subsistence resident scenario (CRCIA).

Seasonality. The research described in Section 3.2.4 suggests that a seasonal difference in potential aboriginal exposure to a contaminated environment exists. Present-day tribal members practicing strict adherence to a traditional way of life and consuming fresh food would be subject to a potentially large seasonal variation in exposure. However, because the traditional native diet for all members of the tribe was comprised of roughly one-third resident fish, one-third large mammals, and the remaining one-third of roots and berries; and because the preservation of food for later consumption is known to have occurred; it is reasonable to assume that diet and exposure remained constant throughout the year regardless of gender.

Gender. Due to the shared division of labor between men and women, there would have been little variation in exposure due to gender-specific traditional activity. Tribal men, women, and children would have be exposed to contaminated surface water and sediment through the traditional methods of fishing and gathering riparian vegetation (including the water potato). Surface water was also used for bathing and cooking that would have resulted in additional exposure to all tribal members.

Potential exposure factors that are inclusive of the most conservative exposure pathways and consumption rates for all tribal individuals are presented in Table 3-26a. The Traditional Subsistence exposure factors presented have been developed under the assumption that the traditional subsistence lifestyle involved residing within the floodplain almost the entire year.

The justification for the values assigned for each exposure factor are largely derived from the Stuart Harris and Barbara Harper article titled “A Native American Exposure Scenario” that was published in *Risk Analysis*; the article provided representative values for the Umatilla Tribe that were generated through interviews with tribal members. The soil and sediment ingestion rate used for adults and children is 300 milligrams (mg) per day, derived from a campground study cited in the 1999 EPA Region 10 Supplemental Guidance for Soil Ingestion Rates. EPA also recommends that 300 mg per day ingestion rate be used for a “soil contact intense” adult exposure scenario. The dermal contact rate for soil that will be used in the risk calculations is 0.8 mg/cm^2. This value represents a midrange adherence rate, based on studies by Kissel et al. and Holmes et al. The skin surface area of 2500 cm^2 used for the soil exposure route represents the face, hands, and forearms for adults as defined by EPA; for children aged 0 to 6, the value used is 2200 cm^2 and represents the head, hands, forearms, lower legs, and feet. For exposure to sediment, the skin surface area used for adults is 18,000 cm^2 and 6500 cm^2 for children, representing full body exposure. Exposure frequency for tribal members to sediment and surface water (incidental ingestion pathway) is 210 days per year, the equivalent of 7 months when weather constraints are considered. The exposure frequency for all other routes and pathways is 365 days per year. Surface water ingestion of 3 liters per day for adults represents greater consumption of water compared to the EPA suggested value of two liters per day for average total fluid intake; the child ingestion rate is 1.5 liters per day is also equivalent to 150% of the EPA suggested value. It is assumed that the Coeur d’Alenes consume more water based on their active lifestyle and the climate in the Coeur d’Alene Basin. The fish consumption value was derived from interviews conducted by Harris and Harper; the diet for the Umatilla Tribe largely consists of fresh and dried salmon and resident fish from the Columbia River. Similarly, the Coeur d’Alenes are dependent upon fish from the Coeur d’Alene River, and the rate of 540 grams per day is used in this risk assessment. The 574 grams per day for a 70 kilogram adult as a consumption rate for the water potato is the EPA recommended intake for fruits and vegetables by urban and suburban Native American. This value is equivalent to 8.2 grams per kilogram per day for the traditional scenario. Some studies on the traditional subsistence diet have shown higher consumption rates, but the interviews conducted by Harris and Harper indicated that the Umatilla ingestion rate is closest to the EPA value.

Current Subsistence Scenario

The Current Subsistence exposure factors requested by the Coeur d'Alene Tribe are intended to represent current tribal members utilizing traditional hunting and gathering activities and a subsistence diet only. As suggested in characterizing traditional activities, potential exposure factors that are inclusive of the most significant pathways are included in Table 3-26b. These estimates reflect conservative values for potential exposure pathways and consumption rates for all tribal individuals.

The exposure duration for current subsistence activities is reduced to 61 days per year for exposure to surface water, sediment, and soil. This value represents the warmest two months of the year for a permanent residence in the floodplain. A fish ingestion rate of 170 grams per day for 365 days per year is assumed to represent the 95^{th} percentile consumption rate. This value was derived from a study of four Columbia River tribes and is outlined in EPA's Exposure Factors Handbook (USEPA 1997a). The skin surface area for the current subsistence scenario is increased to 5700 cm^2 for adults and 2800 cm^2 for children to represent more dermal exposure during the summer months. These values are EPA's suggested values for outdoor exposure. The ingestion rate for wild plants harvested in the floodplain is 1.6 grams per kilogram per day, equal to 20% of the traditional subsistence ingestion rate of 8.2 grams per kilogram per day.

3.4 QUANTIFICATION OF LEAD EXPOSURE

3.4.1 Child Lead Model Overview

The current EPA risk assessment method for evaluating lead uses a mathematical model designed to predict the probable blood lead (PbB) concentrations for children between 6 months and 84 months of age who have been exposed to lead through environmental media (air, water, soil, dust, and diet). The EPA model is referred to as the Integrated Exposure Uptake Biokinetic (IEUBK) Model (USEPA 1994a). The model has the following four functional components:

- **Exposure Component:** The exposure component uses environmental media-specific consumption rates and lead concentrations to estimate media-specific lead intake rates for air, water, soil, dust, and diet.

- **Uptake Component:** The uptake component uses media-specific fractional uptake and lead intake into the lungs or digestive tract to estimate the amount of lead absorbed into the child's blood.

- ! **Biokinetic Component:** The biokinetic component accounts for the transfer of lead between blood and other body tissues, or the elimination of lead from the body altogether.

- ! **Probability Distribution Component:** The probability distribution component shows a probability of a certain outcome (e.g., a PbB concentration greater than 10 µg/dl of blood in an exposed child based on the parameters used in the model).

The IEUBK Model combines assumptions about lead exposure and uptake with assumptions on how lead behaves in the body to predict a central tendency estimate (CT) PbB concentration for a child between 6 months and 84 months of age. Children in this age group are considered by the EPA to be sensitive age group for lead exposure because, compared to older children, they ingest more soil, absorb more lead from the gastrointestinal tract, and are more sensitive to the effects of lead. Within the 6 to 84 month age group, children between 24 and 36 months are especially sensitive to lead health effects because blood lead levels tend to peak at this time when children are especially vulnerable to neurological effects at this stage in their neurological development (Rodier 1995).

The IEUBK's estimated risk of elevated blood lead levels corresponds to cumulative exposure to a multimedia set of environmental lead levels, generally at and around a residence, with which a child or group of children would have contact while living there. This estimated risk is intended to describe the potential for elevated blood lead for any children who would have similar exposure, not just the current residents (Hogan et al. 1998).

In addition to predicting a CT PbB concentration, an estimation of variation in PbB is applied to the CTE to predict the probability of an individual child's PbB concentration exceeding a given PbB level. The EPA and the Centers for Disease Control and Prevention (CDC) have determined that childhood PbB concentrations at or above 10 µg/dl present risks to the child's health. Therefore, the target (acceptable) distribution of childhood PbB concentrations is one in which there is a probability of no more than 5 percent that the PbB concentration of a typical child will exceed 10 µg/dl (USEPA 1994a).

3.4.2 Adult Lead Model Overview

The EPA has developed an adult lead model (USEPA 1996c), which is designed to protect adult women of child-bearing age such that the 95th percentile value for fetal, PbB concentration is no more than 10 µg/dl. The developing fetus is the most sensitive population for adult worker exposure. Inputs to the model should be CT values, rather than RME values, because potential variability is accounted for using a geometric standard deviation (GSD) to approximate a potential distribution of PbB concentration.

The model estimates a PbB concentration using the following formula:

$$PbB_{\text{maternal, central}} = PbB_0 + [(BKSF \times SC \times IR_s \times AF_s \times EF_s) / AT] \qquad (17)$$

where

$PbB_{maternal, central}$	=	Maternal geometric mean blood lead concentration (µg/dl)
PbB_0	=	Baseline maternal blood lead concentration (µg/dl)
BKSF	=	Biokinetic slope factor (µg/dl per µg/day)
SC	=	Soil concentration at the site (mg/kg)
IR_s	=	Ingestion rate (g/day)
AF_s	=	Absorption fraction for soil
EF_s	=	Exposure frequency for contact with site soils
AT	=	Averaging time (the total period during which soil contact may occur, i.e., 365 days/year)

and

$$PbB_{maternal, goal} = \frac{PbB_{fetal, 0.95}}{(GSD^{1.645} \times R)}$$

where

$PbB_{maternal, goal}$	=	Goal for the mean blood lead concentration for pregnant women
$PbB_{fetal, 0.95}$	=	Goal for the 95th percentile blood lead concentration for fetuses born to women having been exposed to lead in site soils (10 µg/dl)
GSD	=	Geometric standard deviation for adults
1.645	=	Distribution variable related to percent above geometric mean blood lead concentration; i.e., student t value for $t_{0.95}$
R	=	Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration; the EPA default value (0.9) was used in this assessment

3.5 SUMMARY OF EXPOSURE ASSESSMENT

Chemical intakes were calculated as described in previous sections and are provided in Appendix A. The chemical intakes have been combined with the toxicity information presented in Section 4 to calculate the cancer risk and the noncancer hazard for the non-lead metals for each exposure scenario (Section 5). The results of the risk analysis for lead are presented in Section 6.

Figure 3-1a Basin Study Regions

Figure 3-1b Census Block Groups Overlaid Onto Basin Study Areas

Figure 3-2 Coeur d'Alene River Basin School District Enrollment 1990 to 2000

Figure 3-3 Lower Basin Conceptual Site Model

Figure 3-4 Kingston Conceptual Site Model

Figure 3-5 Side Gulches Conceptual Site Model

Figure 3-6 Osburn Conceptual Site Model

Figure 3-7 Silverton Conceptual Site Model

Figure 3-8 Wallace Conceptual Site Model

Figure 3-9 Nine Mile Conceptual Site Model

Figure 3-10 Mullan Conceptual Site Model

Figure 3-11 Blackwell Island Conceptual Site Model

Figure 3-12 Baseline Risk Assessment for Lower Basin Area “Southwestern Section”

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Figure 3-13 Baseline Risk Assessment for Lower Basin Area “Central Section”

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Figure 3-14 Baseline Risk Assessment for Lower Basin Area "Northeastern Section"

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Figure 3-15 Baseline Risk Assessment for Kingston Area

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Figure 3-16 Baseline Risk Assessment for Side Gulches Area

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Figure 3-17 Baseline Risk Assessment for Silverton Area

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Figure 3-18 Baseline Risk Assessment for Wallace Area

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Figure 3-18 continued

Figure 3-19 Baseline Risk Assessment for Osburn, Silverton and Wallace Areas Combined, Soil/Sediment Sampling Locations

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Figure 3-20 Baseline Risk Assessment for Osburn, Silverton and Wallace Areas Combined, Surface Water Sampling Locations

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Figure 3-21 Baseline Risk Assessment for Nine Mile Area, Soil/Sediment Sampling Locations

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Figure 3-22 Baseline Risk Assessment for Nine Mile Area, Surface Water Sampling Locations

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Figure 3-22 continued

Figure 3-23 Baseline Risk Assessment for Nine Mile Area, Groundwater Sampling Locations

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Figure 3-24 Baseline Risk Assessment for Mullan Area “West Section”

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Figure 3-24

Figure 3-25 Baseline Risk Assessment for Mullan Area “East Section”

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Figure 3-25

Figure 3-26 Baseline Risk Assessment for Blackwell Island Area

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Figure 3-26

Table 3-1 Summary of Basin Geographic Areas and Population (Source: 1990 Census Data)

Table 3-2 Basin Demographics Over Time (Source: County Profiles of Idaho, IDOC and 1990 Census)

Table 3-3 Census Block Groups Falling Partially Outside of Basin Study Area Boundaries (Source: 1990 Census)

Table 3-4 Summary Population Characteristics

Table 3-5 Household Characteristics (Source: 1990 Census)

Table 3-6 Housing Characteristics (Source 1990 Census)

Table 3-7 Comparison f Median Values of Housing (Source: 1990 Census)

Table 3-8 Student Population and Educational Attainment (Source: 1990 Census)

Table 3-9 Basin Area Household Income (Source: 1990 Census)

Table 3-10 Shoshone County Profile (Source: Profile of Rural Idaho, IDOC)

Table 3-11 Kids Count Data as Presented in Yearly Reports (Source: Idaho KIDS COUNT: Profiles of Child Well-Being 1996-2000)

Table 3-12 1999-2000 Kids Count Data - Economic Well Being (Source: Idaho KIDS COUNT: Profiles of Child Well-Being 1999-2000 and School District Data)

Table 3-13 1999-2000 Kids Count Data - Child Population Change (Source: Idaho KIDS COUNT: Profiles of child Well-being 1999-2000)

Table 3-14 School District Data (Source: School Districts #391, 392, and 393)

Table 3-15 School District Enrollment by Grade (Source: School Districts #391, 392, and 393)

Table 3-16 Estimated Child Population and Sample Population (Sources: 1990 Census, Idaho KIDS COUNT, and School District Data)

Table 3-17 Public and Private Sewer and Water Hookups (Source: 1990 Census and 1999 Sewer District (SD) data)

Table 3-18 Estimated Number of Housing Units by Basin Area (Source: 1990 Census and 1999 Sewer District Data)

Table 3-19a Summary of Exposure Pathways Quantified in HHRA

Table 3-19a continued

Table 3-19a continued

Table 3-19a continued

Table 3-19a continued

Table 3-19b Tribal Exposure Routes To Be Considered

Table 3-20 Summary of Exposure Point Concentrations for Reasonable Maximum Exposure

Table 3-20 continued

Table 3-20 continued

Table 3-21 Number of Samples Used to Calculate Exposure Point Concentrations

Table 3-22 Residential Exposure Factors

Table 3-22 continued

Table 3-23 Neighborhood Recreational Exposure Factors

Table 3-23 continued

Table 3-23 continued

Table 3-24 Public Recreational Exposure Factors

Table 3-24 continued

Table 3-24 continued

Table 3-25 Occupational Exposure Factors

Table 3-26a   Traditional Subsistence Scenario Exposure Factors

Table 3-26a continued

Table 3-26b Current Subsistence Scenario Exposure Factors

Table 3-26b continued